

Section 1

Introduction

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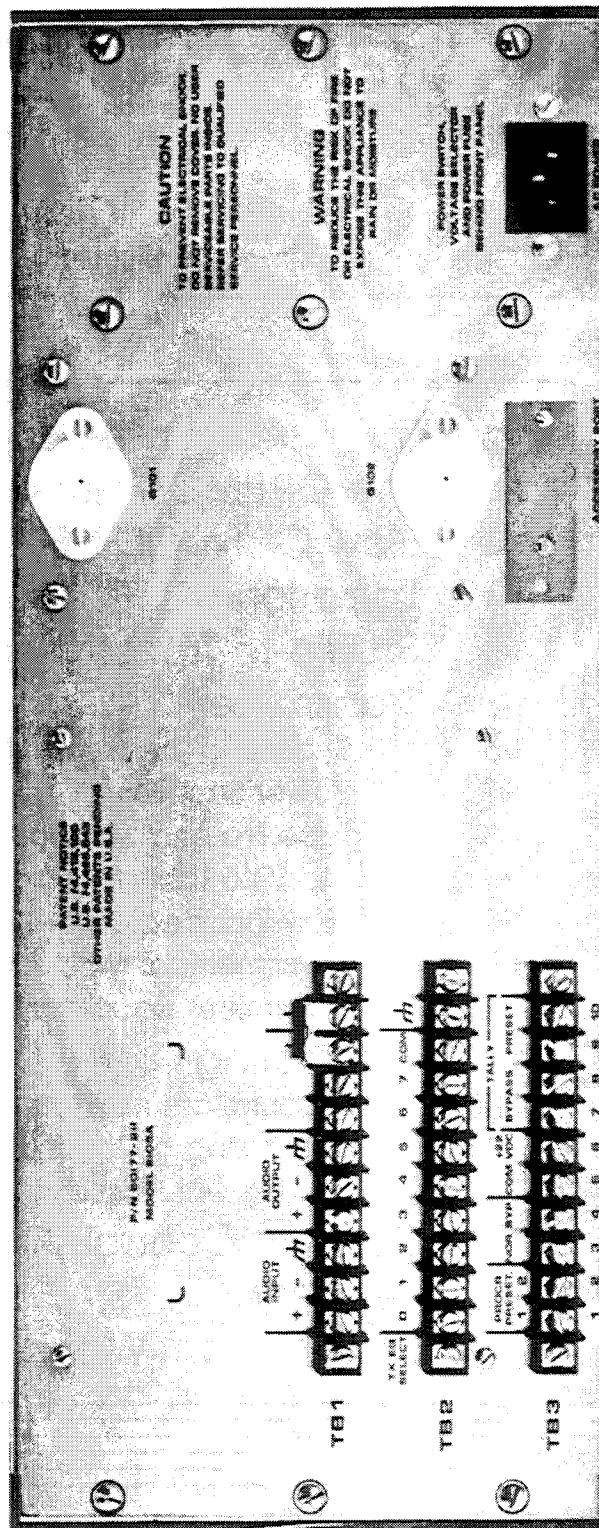
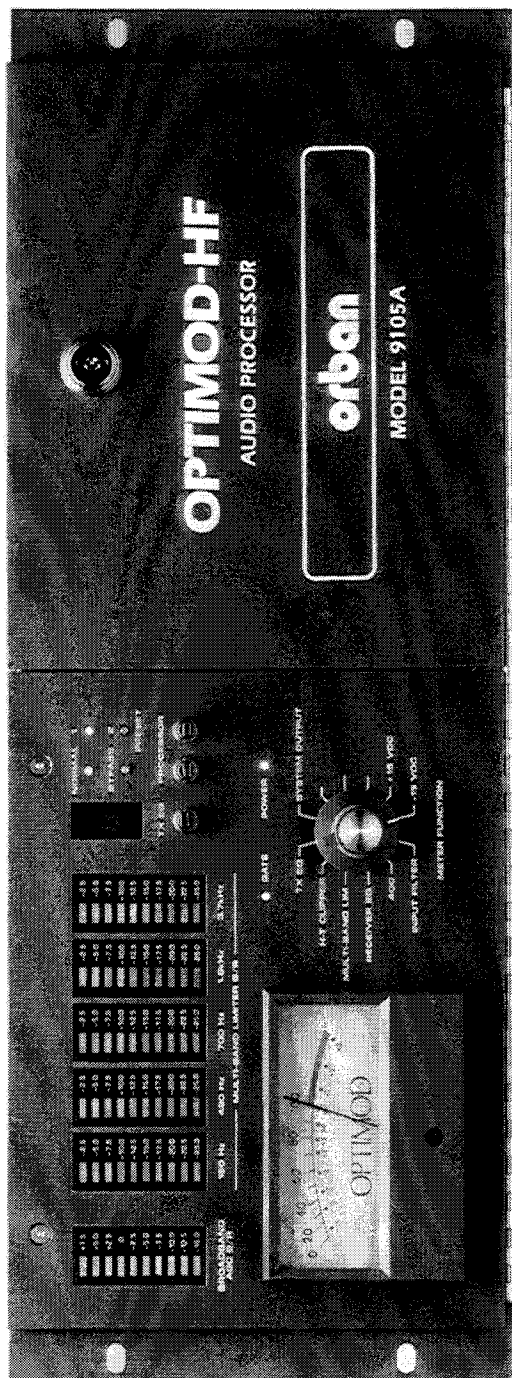


Fig. 1-1: Front and Rear Panels

The 9105A OPTIMOD-HF Audio Processor

Orban's 9105A OPTIMOD-HF Audio Processor is specifically optimized for international high-frequency/shortwave broadcast, both conventional AM and SSB. It is designed specifically to punch through the noise and interference in the HF bands, and to produce highly intelligible speech even on very narrow-band radios.

- OPTIMOD-HF **rides gain** over an adjustable range of up to 25dB, compressing dynamic range and compensating for operator gain-riding errors and for gain inconsistencies in automated systems.
- OPTIMOD-HF **increases the density and loudness** of program material by multi-band limiting, multi-band distortion-canceling clipping, and Hilbert-Transform Clipping® — improving the consistency of the station's sound and increasing loudness and definition remarkably, without producing audible side-effects.
- OPTIMOD-HF **is designed to be installed at the transmitter**, replacing *all* processing normally employed at the transmitter site, including compressor, protection peak limiters, and the high- and low-pass filters and clippers normally included within the transmitter.
- OPTIMOD-HF **compensates for the high- and low-frequency roll-offs** of typical AM receivers with a fully-adjustable program equalizer — providing up to 20dB of high-frequency (at 5kHz) boost without producing the side-effects encountered in conventional processors.
- OPTIMOD-HF **precisely controls peak levels** to prevent over-modulation.
- OPTIMOD-HF **is as loud as an RF clipper**, yet much cleaner sounding and more intelligible.
- OPTIMOD-HF **compensates for inaccuracies in the pulse response** (tilt, overshoot, ringing) of transmitters and antenna systems with a powerful four-parameter transmitter equalizer offering eight remote-selectable presets.
- OPTIMOD-HF **has two remotely-selectable processing modes** to allow processing characteristics (amount of limiting and clipping) to be changed to match programming or propagation conditions.
- OPTIMOD-HF **controls the transmitter bandwidth** to meet EBU, CCIR, or FCC specifications, regardless of program material or equalization.
- OPTIMOD-HF **is supplied with a Monitor Roll-off Filter** for accurately simulating the frequency response of an "average" HF receiver during off-air monitoring.

How OPTIMOD-HF Audio Processing Is Different

OPTIMOD-HF achieves an exceptionally favorable balance between loudness, distortion, and intelligibility. It fully exploits the limits of the standard $\pm 5\text{kHz}$ HF channel. Its capabilities may even exceed the limits of some HF transmitters and antennas.

Because OPTIMOD-HF incorporates several audio processing innovations that are unique to Orban products, you should not assume that it can be operated in the same way as less sophisticated processors. If you do, you may get disappointing results.

Take a little time now to familiarize yourself with the 9105A — a small investment of your time now let you achieve much better audio quality.

The rest of Section 1 explains how OPTIMOD-HF fits into the AM broadcast plant. Section 2 tells how to install OPTIMOD-HF. Section 3 tells how to properly operate OPTIMOD-HF.

OPTIMOD-HF was designed to improve intelligibility by pre-processing for the limitations of the average portable shortwave radio (while avoiding audible side-effects and compromises in loudness or coverage).

For best results, **feed OPTIMOD-HF unprocessed audio**. No other audio processing is necessary or desirable. If you wish to place level protection prior to your studio/transmitter link (STL), use the Orban Model 464A "Co-Operator" Compressor/Limiter/HF Limiter/Clipper. The 464A can be adjusted so that it substitutes for the broad-band AGC in OPTIMOD-HF.

Location of OPTIMOD-HF

At the transmitter is best

The best location for OPTIMOD-HF is as close as possible to the transmitter, so that OPTIMOD-HF's output can be connected to the transmitter through a circuit path that introduces no change in the shape of the carefully peak-limited waveform at OPTIMOD-HF's output. A wire, with no active circuitry, is ideal.

Severe changes in the shape of the waveform can be caused by passing it through a circuit with non-constant group delay and/or non-flat frequency response in the 30–6,000Hz range. Deviation from flatness and phase-linearity will cause spurious modulation peaks because the shape of the peak-limited waveform is changed. Such peaks add nothing to average modulation. Thus, the average modulation must be lowered to accommodate those peaks so that they do not over-modulate.

To achieve satisfactory waveform fidelity, with negligible overshoots, the deviation from linear phase must be less than $\pm 10^\circ$, 30–6000Hz. Frequency response must be less than 3dB down at 0.15Hz (this is *not* a typographical error!), and less than 0.1dB down at 6kHz.

Where access to the transmitter plant is not possible

Sometimes, it is not possible to locate OPTIMOD-HF at the transmitter, and it must instead be located on the studio side of the link connecting the audio plant to the transmitter. (The link might be telephone/post lines, analog microwave radio, or various types of digital paths.)

This situation will yield lower performance than if OPTIMOD-HF is connected directly to the transmitter, because artifacts that cannot be controlled by OPTIMOD-HF will be introduced in the link to the transmitter, by transmitter peak limiters, clippers, filters, and the transmitter itself. Even so, you should expect a noticeable improvement in sound.

In our experience, locating OPTIMOD-HF at the studio site instead of the transmitter site will usually result in 2–4dB lower average modulation level, and possibly reduced intelligibility.

Studio-Transmitter Link

The audio received at the transmitter site should be of as good quality as possible. To achieve the full audible benefit of OPTIMOD-HF processing, a studio-to-transmitter link (STL) that is as flat as the bandwidth of OPTIMOD-HF (4.5kHz, 5.0kHz, 5.5kHz, or 6.0kHz, as ordered) should be used.

Because the audio processor controls peaks, it is not important that the audio link feeding OPTIMOD-HF's *input* terminals be phase-linear. However, the link should have low noise, flattest possible frequency response from 30–6,000Hz, and low non-linear distortion.

OPTIMOD-HF at the transmitter — gain control before the STL

If the audio link between the studio and the transmitter is noisy, the audibility of this noise can be minimized by performing the AGC function at the studio site. AGC applied before the audio link improves the signal-to-noise ratio because the average level on the link will be greater.

Further, many STLs require level control to prevent the STL from being overloaded.

To apply such level control, we recommend the Orban Model 464A “Co-Operator” Compressor/Limiter/HF Limiter/Clipper prior to the STL transmitter. The 464A is a two-channel device; the other channel can be used for a second link or for backup. The 464A performs the function of OPTIMOD-HF's internal broadband automatic gain control (AGC), while simultaneously protecting the STL. If this is done, OPTIMOD-HF's broad-band AGC should be defeated by re-positioning jumpers on Card #6 (see Fig. 2-3 on page 2-9).

Where access to the transmitter plant is not possible

All audio processing must be done at the studio, and any damage that occurs later must be tolerated.

If a broad-band phase-linear link to the transmitter is available, one can minimize the usual performance degradations caused by installing OPTIMOD-HF at the studio. Use OPTIMOD-HF at the studio to directly feed the STL. The output of the STL should directly feed the transmitter, with no intermediate processing of any kind (limiting, clipping, low- and high-pass filters). A broad-band phase-linear link would need to meet the same requirements as required for the transmitter: the deviation from linear phase must be less than $\pm 10^\circ$, 30–6,000Hz, and frequency response must be less than 3dB down at 0.15Hz, and less than 0.1dB down at 6kHz.

Where only an audio link is available, feed the audio output of OPTIMOD-HF directly into the link. If possible, the transmitter protection limiter should be adjusted so that audio is normally just below the threshold of limiting: The transmitter protection limiter should respond only to signals caused by faults or by spurious peaks introduced by imperfections in the link. Where maximum quality is desired, it is wise to request that all equipment in the signal path after the studio be carefully aligned and qualified to meet the appropriate standards for bandwidth, distortion, group delay and gain stability, and that such equipment be re-qualified at reasonable intervals.

Transmitter

The behavior of an FM station is more or less determined by the behavior of the exciter. Alas, this is not true in HF broadcast! The performance of an HF broadcast station is *highly dependent* upon the high-power sections of the transmitter, and upon the behavior of the antenna system.

The extremely high average power and the pre-emphasized high-frequency component of audio processed by OPTIMOD-HF put great demands upon the performance of the transmitter and antenna system. While improved results can be expected from most plants, outstanding results can only be achieved by plants with transmitters that can accurately reproduce OPTIMOD-HF's output without changing the *shape* of the waveform, and with wide-band, symmetrical antenna arrays.

Any AGCs, compressors, limiters, and clippers which follow OPTIMOD-HF in the circuit must be bypassed. OPTIMOD-HF provides all of these functions itself.

Bypassing the transmitter's internal filters and clippers:

Most HF transmitters contain built-in filters and clippers after their audio inputs. The filters may have various purposes: A low-pass filter is often included to ensure that the transmitter's output spectrum adheres to the occupied bandwidth specifications of the governing authority. A high-pass filter may be present to protect the transmitter from damage. Safety clippers are often present to prevent the modulator from being over-driven.

As discussed in earlier sections, accurate reproduction of OPTIMOD-HF's output requires that the deviation from linear phase must be less than $\pm 10^\circ$, 30–6,000Hz.

Frequency response must be less than 3dB down at 0.15Hz, and less than 0.1dB down at 6kHz.

The highly processed output of OPTIMOD-HF is carefully band-limited and peak-controlled. This output will often contain waveform with flat-tops — like square waves. If the transmitter has constant group delay above 30Hz, these difficult waveforms will be transmitted intact and peak modulation will be accurately controlled.

However, if low-frequency response is more than 3dB down at 0.15Hz, as would be the case if a high-pass filter is present, the group delay above 30Hz will *not be constant*. For example, a typical 50Hz high-pass filter introduces significant non-constant group delay to 500Hz — ten times the cut-off frequency. This non-constant group delay will tilt the square waves produced by OPTIMOD-HF. The tilt increases the peak level of the audio waveform, but not the average level. This will force you to decrease the average modulation to prevent the spurious peaks from over-modulating.

Similarly, a typical EBU 4.5kHz filter will introduce significant non-constant group delay down to 1kHz — about one-fourth the cut-off frequency. This will cause overshoot in the highly-processed waveforms produced by OPTIMOD-HF. The overshoot increases the peak level of the audio waveform, but not the average level. This will force you to decrease average modulation even more.

Alternatively, if you do *not* decrease the average modulation to accommodate the spurious peaks introduced by the filters, the peaks will be clipped by the transmitter's safety clipper. This will introduce out-of-band energy that will almost certainly violate the limits on occupied band-width specified by the governing authority, and will greatly degrade the spectral control provided by OPTIMOD-HF.

To achieve the full performance capability built into OPTIMOD-HF, any filters in the transmitter must be bypassed. This is essential!

OPTIMOD-HF contains very capable low-pass and high-pass filters that are fully capable protecting the transmitter and controlling occupied band-width. Because of their location within OPTIMOD-HF, the internal filters *do not introduce spurious modulation peaks*.

Any built-in peak clippers in the transmitter should be defeated.

OPTIMOD-HF contains a safety clipper that is fully capable of controlling transmitter modulation without introducing out-of-band spectrum. If the drive level to the transmitter is even *slightly* excessive, the transmitter clipper will be driven hard enough to create excessive spurious spectrum. To prevent this possibility, defeat any clipper within the transmitter.

Power supplies:

An HF transmitter is required to provide 150% of unmodulated carrier power when it is modulating 100%. High-voltage power supplies are subject to two major problems: sag and resonance.

Sag is a result of inadequate steady-state regulation. It causes the conventional "carrier shift" that is seen on a modulation monitor.

A more serious problem is dynamic carrier shift, or "bounce". This has been known to cause up to 3dB loudness loss. It is usually caused by resonances in the power supply's LC filter network. Any LC network has a resonant frequency. In order

to achieve reasonable efficiency, the power supply filter network must be under-damped. Therefore, this resonance is excited by high modulation, and can cause over-modulation on the low-voltage peaks of the resonance.

Curing bounce is not at all straightforward because of the requirement that the power supply filter smooth the DC sufficiently to achieve low hum. One approach that has been employed is use of a 12-phase power supply. Upon rectification, the ripple component of the DC is down about -40dB *without filtering*. A single-capacitor filter can thus be used, eliminating the filter inductor as a potential source of resonance with the capacitor.

Other sources of resonance include the modulation reactor and modulation transformer in conventional plate-modulated transmitters. Such transmitters will not greatly benefit from a 12-phase power supply.

A new generation of transmitters employ switching modulation techniques to control "bounce" far better than do older designs. One would expect transmitters employing "out-phasing" modulation schemes to also benefit substantially from a tighter power supply.

Tube life and bass roll-off:

Many broadcasting organizations place a high premium on achieving maximum life from the expensive power tubes used in high-power transmitters. Experience has shown that tube life is often increased if a bass roll-off is applied to the audio, because audio processed in this way places less stress on the transmitter's modulator. OPTIMOD-HF provides a switchable 150Hz 6dB/octave high-pass filter for this purpose.

In addition to improving tube life, bass roll-off will also reduce the intermodulation distortion produced by envelope detectors in receivers during selective fading due to the sidebands' becoming asymmetrical.

Because bass takes considerable power from the modulator's power supply, rolling off the bass also tends to reduce mains power cost.

Further, rolling off the bass will almost always reduce power supply bounce.

Pre-1965 transmitters:

Some older transmitters were under-designed by today's standards, because modern audio processing techniques to increase average modulation had not yet been developed, and because the designers of those transmitters assumed that *average* power demands on the modulator would be relatively small. If you have a transmitter designed before 1965, it should be carefully monitored to make sure that OPTIMOD-HF processing is not overheating the modulation transformer, the modulation reactor, or the power supply. The high-frequency boost performed by OPTIMOD-HF can cause unusually high voltages in the final amplifier, which could cause arcing and/or component breakdown (although the latter is very rare). There is no hard-and-fast cure for such problems. They almost always require substantial modification of the transmitter, including the addition of heavier-duty components and perhaps of a whole new power supply for the modulator alone.

Slew-induced distortion:

The audio community has given much attention recently to “transient intermodulation distortion” or, more correctly, “slew-induced distortion” (SID) in feedback amplifiers. This distortion is caused by an amplifier with a maximum available rate of change for its output waveform. Such an amplifier exhibits SID when program waveforms try to force its output to change faster than this “slew-rate limit”.

The cause of this distortion is usually an open loop response which starts to roll off at a very low frequency. Since this roll-off is usually introduced *after* the input stage, the output of the input stage is forced by feedback to be highly pre-emphasized (to overcome the roll-off in the following stage). This pre-emphasis makes it easy for input stage to overload — which is the direct cause of SID.

It is not widely realized that certain transmitters are *extremely* prone to this type of distortion if they employ overall audio feedback around the transmitter (using rectified RF to supply the feedback signal). Because of the delays involved in the transmitter, it is necessary to roll off the open loop response at a very low frequency to make the feedback loop stable. This feedback improves the steady-state distortion measurements (total harmonic distortion and SMPTE intermodulation tests). However, the conditions for severe SID still exist. Such distortion is highly offensive to the ear; it is a plausible explanation for why some transmitters may measure good, but sound bad.

Because the output of OPTIMOD-HF is highly pre-emphasized, it can cause severe audible distortion in a transmitter that has considerable SID. SID is therefore of substantial concern in an OPTIMOD-HF installation. SID can be detected with the CCIF intermodulation test, which involves introducing a pair of high-frequency tones (closely spaced in frequency) to the input of the system being evaluated. The level of the difference frequency that results from passing these tones through the system is then measured.

Curing SID in a transmitter is not simple. The only way to do it is to reduce the amount of overall feedback employed, then to try to compensate for the decreased feedback by decreasing the amount of high-frequency roll-off and, finally, to linearize the modulator stage by stage. THD and/or SMPTE IM test results may well be worse as a result of this process. But the transmitter will probably sound better.

Asymmetrical modulation:

While any AM modulation system is limited by the physics of carrier pinch-off to an absolute negative modulation limit of 100%, it is possible to modulate positive peaks as high as desired. However, in HF broadcasting, it is customary to limit positive peaks to 100% modulation to reduce distortion and to avoid over-stressing high-powered transmitters.

OPTIMOD-HF is designed to make best use of this limitation. OPTIMOD-HF's input conditioning filter contains a time dispersion circuit which makes asymmetrical input material, like voice, substantially symmetrical. There is really nothing lost by not modulating asymmetrically: listening tests easily demonstrate that modulating *symmetrically* (provided that time dispersion has been applied to the audio) produces a considerably louder and cleaner sound than does *asymmetrical* modulation that retains the natural asymmetry of the input program material.

Transmitter equalization:

OPTIMOD-HF's transmitter equalizer can cure *linear* problems caused by the transmitter or antenna system. The transmitter equalizer cannot cure *non-linear* problems, particularly those caused by inadequate power supplies, modulation transformers, or reactors. If any of these components saturate or otherwise fail to perform under heavy power demands, no amount of small-signal equalization will solve their problems.

OPTIMOD-HF was designed with the assumption that one audio processor would be devoted to one transmitter. Thus OPTIMOD-HF provides only one set of controls for its *low-frequency* transmitter equalizer. However, this one transmitter might be switched to many different antenna loads, causing different amounts of overshoot or ringing at high audio frequencies. Eight remotely or locally switchable *high frequency* transmitter equalizer control sets are thus provided.

Monitoring

Modulation monitors and their RF amplifiers:

Many AM modulation monitors (particularly older ones) indicate dynamic modulation inaccurately — even though they may accurately measure sine-wave modulation. This occurs when the audio filter after the demodulator diode is not phase-linear, and produces overshoot and ringing. An incorrectly designed modulation monitor may over-indicate by as much as 3dB.

When modulation monitors are used at locations distant from the transmitter, they are driven from highly selective RF amplifiers. These have been known to suffer from similar problems. They can overshoot and ring if the passband filters are too sharp, causing the monitor to falsely indicate high modulation.

If your modulation monitor does not agree with an oscilloscope monitoring the RF envelope at the common point, do not assume that the monitor is indicating fast peaks that your eye cannot see. A probable cause of the disparity is overshoot in the modulation monitor or its RF amplifier. If you observe this problem, we recommend that you assume that what you see on the oscilloscope is correct — oscilloscopes are designed to display pulse waveforms accurately.

Note also that modulation percentages will vary depending on where in the transmission system the RF sample is taken. Depending on the location observed, actual modulation can be either lower or higher than modulation observed at the common point. What is crucial is whether the carrier has in fact been pinched-off at the final amplifier, because carrier pinch-off is what causes splatter. If the carrier appears slightly suppressed because of a peculiar choice of monitoring point within the system, negative peaks will “fold around” zero instead of cutting off. This causes no problem with out-of-band radiation, and far-field radiation is likely to show normal AM modulation envelopes. We therefore recommend that you use an RF sample from the final amplifier.

Monitoring on loudspeakers and headphones

The output of a loudspeaker fed from the modulation monitor typically sounds shrill and strident because, unlike virtually all real HF radios, the modulation monitor and loudspeaker have a flat response. Roll-Off Filtering can be used to supply monitors with audio that more closely resembles that heard over a typical receiver.

A Monitor Roll-Off Filter is provided with the OPTIMOD-HF processor. The filter is a small, separate unit designed to be installed between the modulation monitor and the monitor amplifier. (See 2-20 for installation instructions). It provides an adjustable 18dB/octave roll-off to complement the GREEN pre-emphasis module (see page 3-12) used in the OPTIMOD-HF Receiver Equalizer.

If a different tonal balance is desired for off-the-air monitoring, install a simple program equalizer after the Monitor Roll-Off Filter, and boost the 5kHz region to taste.

In live operations, highly processed audio often causes a problem with the presenter's headphones. If the phones are fed directly from the off-air monitor, the headphone sound will be fatiguing and strident. And they will tend to cause high-frequency acoustic feedback if the presenter has his headphones loud. Such problems can be avoided if the presenter's headphones are driven directly from the program line or, better, by an inexpensive compressor connected to the program line. If the presenter *must* use the off-air monitor, drive the headphone amplifier from the output of the Monitor Roll-Off Filter.

If the presenter relies principally on headphones to determine whether the station is on the air, simple loss-of-carrier and loss-of-audio alarms should be added to the system. Such alarms could be configured to cut off audio to the presenter's phones when an audio or carrier failure occurs.

A good monitoring system that can be easily heard where OPTIMOD-HF is mounted will facilitate adjustments.

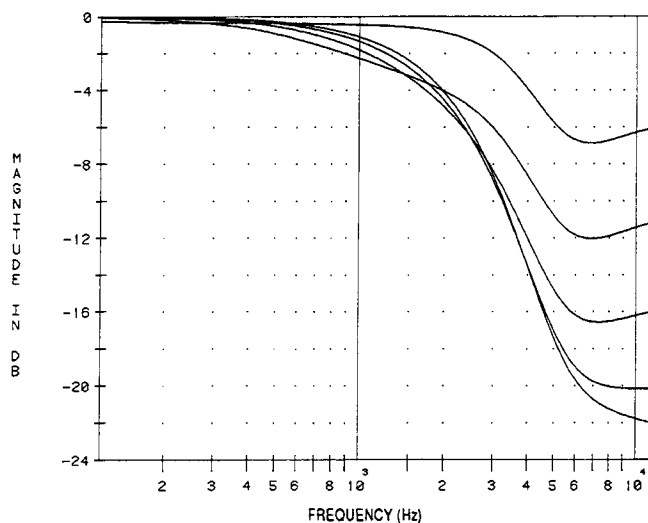


Fig. 1-2: Frequency Response, Monitor Roll-Off Filter
(For various settings of ROLL-OFF control)

Remote Control

OPTIMOD-HF has several features to facilitate interface with automated transmission systems:

- 1) Two processor presets can be selected by remote control. These presets allow OPTIMOD-HF to be adjusted for two different types of processing. For example, this feature might be used to choose more extreme processing when jamming is encountered, or to choose between settings for voice or music. The controls affected are DENSITY and HILBERT-TRANSFORM CLIPPER DRIVE.
- 2) OPTIMOD-HF can be bypassed by remote control to permit measurements to be performed on the rest of the system. In BYPASS, OPTIMOD-HF's safety clippers and its low-pass and high-pass filters are retained in the circuit to protect the transmitter from operator error.
- 3) Eight high-frequency transmitter equalizer presets can be selected by remote control. These change HF transmitter/antenna equalization to compensate for different loads and tuning. See page 2-12 for more information.
- 4) Tallies are provided to indicate the status of the PROCESSOR PRESET and SYSTEM OPERATE/BYPASS logic. These are floating SPST relay contacts, and are available on the rear-panel barrier strip. Contacts are closed in PRESET 2 and SYSTEM BYPASS modes respectively.

Security

To restrict access to the set-up controls, the access door is fitted with a lock. Two keys are supplied. These can be duplicated as necessary. The dealer from whom your OPTIMOD-HF was purchased can supply additional keys, as can the factory. In either case, your Registration Card must be on file at the factory, and you must supply your serial number to obtain replacement keys. If all keys are lost, you can obtain access by removing the two hex-socket screws from the top of the main front panel with a $\frac{5}{64}$ -inch hex wrench (one is supplied with the unit).

If you wish to make the unit's adjustments more secure, obtain similar splined-socket or aircraft tri-point screws (and tools), and use these in place of the hex-socket screws supplied. (Tools for these are not readily found in hardware stores or other places that casual knob-twirlers might frequent.) The screws are $6-32 \times \frac{3}{8}$ -inch 82° flathead, nickel-plated steel.

An internal switch is provided that can defeat all front-panel switches except for the METER SELECTOR. This feature is useful when the station is being operated solely by remote control, and accidental local operation of controls might cause operational errors.

Registration, Warranty, Feedback

Registration Card

There are two good reasons for returning the Registration Card shipped with this product:

- 1) It enables us to inform you of performance improvements and service aids that may be developed; and
- 2) It helps us respond promptly to claims under warranty without having to request a copy of your bill of sale or other proof of purchase.

Please fill in the Registration Card and send it to us today. If it is lost (or you have purchased this unit used), please photocopy the duplicate below, fill it in, and send it to Orban at the address on the inside of the front cover.

Registration Card			
Model # _____	Serial # _____	Purchase Date _____	
Your name _____		Title _____	
Company _____		Telephone _____	
Street _____			
City, State, Mail Code (Zip), Country _____			
Nature of your product application _____			
How did you hear about this product? _____		Purchased from _____	
Comments _____			

Which magazines do you find the most useful to your job?			
☐ Audio	☐ Broadcast Engineering	☐ Broadcast	☐ dB Magazine
☐ Electronic Musician	☐ EQ	☐ Millimeter	☐ Mix
☐ Post	☐ Pro Sound News	☐ Radio & Records	☐ Radio World
☐ RE/P	☐ Sound & Communications	☐ S & VC	☐ TV Broadcast
☐ TV Tech	_____	_____	_____
_____	_____	_____	_____

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Warranty

The warranty, which can be enjoyed only by the first end-user of record, is stated on the separate Warranty Certificate packed with this manual. Save it for future reference. Details on obtaining factory service are provided on page 5-14.

User Feedback Form

We are very interested in your comments about this product. Your suggestions for improvements to either the product or the manual will be carefully reviewed. A User Feedback Form is provided in the back of this manual for your convenience. If it is missing, please write us at the address on the inside of the front cover. Thank you.

Notes:

Section 2

Installation

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CAUTION

The installation and servicing instructions in this manual are for use by qualified personnel only. To avoid electric shock do not perform any servicing other than that contained in the Operating Instructions unless you are qualified to do so. Refer all servicing to qualified service personnel.

6) Equalize transmitter response.

See step 10 on page 2-12.

7) Set audio processing controls.

See step 12 on page 2-17.

8) Install Monitor Roll-Off Filter. (optional)

See step 13 on page 2-20.

9) Complete and return the Registration Card.

The Registration Card enables us to inform you of new applications, performance improvements, and service aids which may be developed, and it helps us respond promptly to claims under warranty without having to request a copy of your bill of sale or other proof of purchase. Please fill in the Registration Card and send it to us today. (If it is lost, there is a duplicate on page 1-13.)

We do not sell our customers' names to advertising agencies.

Installation (Comprehensive Instructions)

Installation begins with checking-out the 9105A and setting option jumpers on circuit cards. The 9105A is mounted in a rack, and connected to power and ground. Audio and remote control signal lines are connected. Transmitter response is equalized, and the audio processing controls are set. Finally, the Monitor Roll-Off Filter is installed, and the air sound is checked.



IMPORTANT

Turn off AC power to the 9105A before removing or installing circuit cards. The AC power switch is located behind the front swing-down meter panel.

- Allow about 2 hours for installation.
- Follow instructions in the order given, as some steps depend on the results of previous steps.

Equipment required:

Oscilloscope

DC-coupled, triggered-sweep, with at least 5MHz vertical bandwidth.

Optional:

RF spectrum analyzer

To look at the occupied bandwidth produced by the transmitter.

1) Unpack and inspect.

If obvious physical damage is noted, contact the carrier immediately to make a damage claim.

- ☐ Make a mental note of how the unit is packed and *save all packing materials*.

If you should ever have to ship a unit (e.g., for servicing), it is best to ship it in the original packing materials since these have been carefully designed to protect the unit.

Packed with the 9105A OPTIMOD-HF Audio Processor:

- 1 Power cord
- 1 3-wire power cord plug adapter (if applicable)
- 4 10-32 × 3/4-inch rack screws
- 1 5/64-inch hex wrench for front-panel screws
- 2 Keys for front-panel door
- 1 Adjustment tool (mounted inside front-panel door)
- 1 Extender card (shipped in the card rack in 9105A)
- 1 Wrench for removing knobs
- 1 ACC-023 Monitor Roll-Off Filter
- 2 Resistors, 620 ohm ±5%, 1/4-watt, carbon film
- 3 Pre-emphasis modules
- 1 Final Factory Qualification Test Results
- 1 Warranty Certificate
- 1 Registration Card
- 1 Operating Manual
- 1 Publication: *Audio Quality in the AM Plant*

- ☐ **B** Set the 9105A on a flat, soft surface.
- ☐ **C** Open the door with the supplied key.
- ☐ **D** Remove the two hex-socket screws at the top of the 9105A's front panel with the a 5/64-inch hex wrench (provided with the 9105A), then tilt the hinged front panel down to reveal the interior.
- ☐ **E** Loosen the four DZUS fasteners on the subpanel by turning each fastener 1/4-turn counterclockwise with a long 3/16-inch or 1/4-inch flat-blade screwdriver.
- ☐ **F** Taking care not to stress the flat cables beneath it, tilt the top of the subpanel outward and to the left to clear the upper chassis lip and the door support rail at the right.
- ☐ **G** Carefully remove each circuit card, check that all IC components are properly seated in their sockets, then return each card to its slot.

Leave the subpanel off and the front cover and door open for now.

If you would like to perform a complete field audit of the 9105A's performance before installing it, see page 4-11.

2) Check line voltage, fuse and power cord.

- ☐ **A** *DO NOT* connect power to the unit yet.



- ☐ **B** Check that the AC POWER switch behind the front panel is set to ON.

c ☐ Check VOLTAGE SELECTOR switches.

The 9105A is shipped wired for 115 or 230V, 50 or 60Hz operation. Refer to the unit's rear panel for your Model # and the inside front cover of this manual for your Model #'s line voltage setting. To change the operating voltage, set the VOLTAGE SELECTOR switch to 115V or 230V, as appropriate (voltages $\pm 15\%$ of the nominal voltage are acceptable).



d ☐ Check the value of the fuse and change it if the value is incorrect.

For safety, the fuses must be Slo-Blo, 3AG $\frac{1}{2}$ -amp for 115V, or "T" type 250mA for 230V.

e ☐ Connect the 9105A's power cord to an appropriate power source.

AC power passes through an IEC-standard mains connector and an RF filter designed to meet the standards of all international electrical safety authorities. The RF filter leaks less than 0.5mA to the chassis when operated from 230V mains, and less than 0.25mA when operated from 115V mains.

The power cord is terminated in a "U-ground" plug (USA standard), or CEE7/7 plug (Continental Europe), as appropriate to your 9105A's Model #. The green/yellow wire is connected directly to the 9105A chassis.

If it becomes necessary to lift this ground to suppress ground loops, do so with a three-prong to two-prong adapter plug, rather than by damaging the power plug. But you should *not* defeat the ground unless absolutely necessary, because it eliminates the intrinsic safety feature of the three-wire system.

WARNING



If the ground is defeated, certain fault conditions in the unit or in the system to which it is connected can result in full line voltage between chassis and earth ground. Severe injury or death can then result if the chassis and earth ground are touched simultaneously.

If you need to change the plug to match your country's standard, and you are qualified to do so, see Fig. 2-1. Otherwise, purchase a new mains cord with the correct line plug attached.

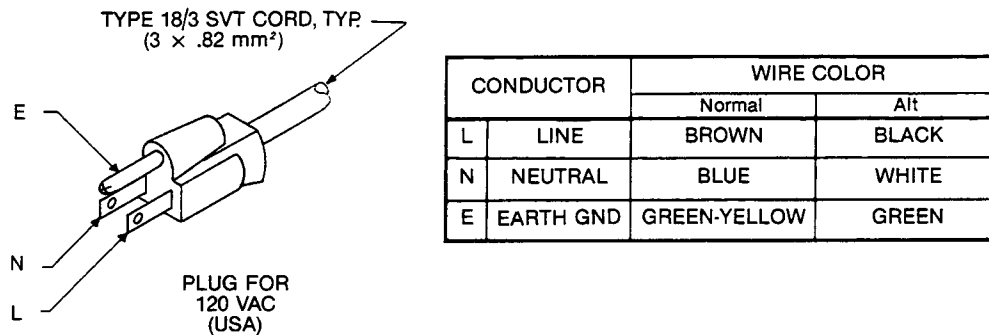


Fig. 2-1: AC Power Plug Wiring

3) Select input sensitivity.

[Skip this step if you want -10dBu to +10dBu input sensitivity.]

Card #4 is shipped with a 20dB pad ahead of the input buffer amplifier. This is suitable for nominal input levels from +10 to -10dBu. If lower input levels (-30 to -10dBu) are used, defeat the pad by re-positioning Card #4's jumper B to the 0dB position (see Fig. 2-2).

If you change any of the initialization option jumpers, mark these changes in this manual for reference (and to eliminate the need to open the unit to check jumper positions in the future).

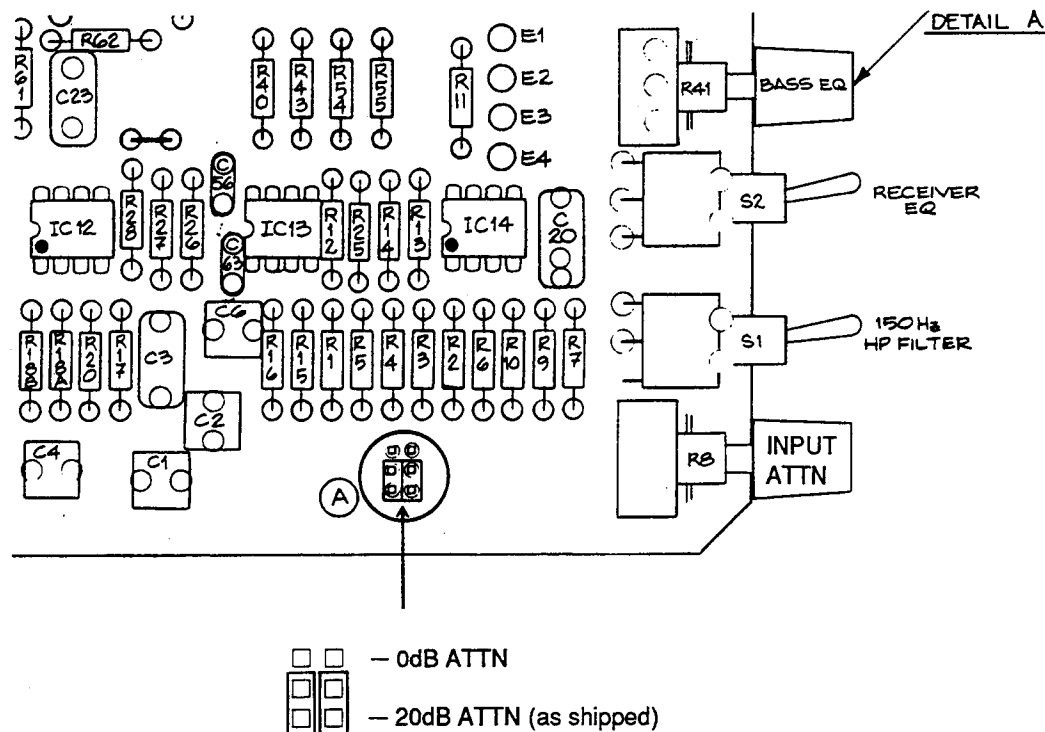


Fig. 2-2: Jumper Positions, Card #4

4) If you are using AGC or compression (such as Orban's Model 464A Co-Operator) at the studio prior to the studio-to-transmitter link:

☐ Defeat broad-band AGC.

OPTIMOD-HF's broad-band automatic gain control should be defeated so the two AGCs don't fight each other (see page 1-5 for more information). To defeat the broad-band AGC, re-position the jumpers marked "A" on Card #6 as shown in Fig. 2-3.

☐ Set the 464A's controls according to **Broadcast Transmission** on page 3-4 of the 464A's Operating Manual.

☐ Set the 464A's HF LIMIT PRE-EMPHASIS control to match the pre-emphasis in your STL.

If you are using telephone or post lines that do not use pre-emphasis (or any other STL that does not use pre-emphasis), set the 464A's HF LIMIT switch to DEFEAT.

Do not readjust R2 according to the footnote in the 464A Operating Manual; leave it in its factory-set position.

☐ Turn the 9105A's GATE THRESH control fully clockwise.

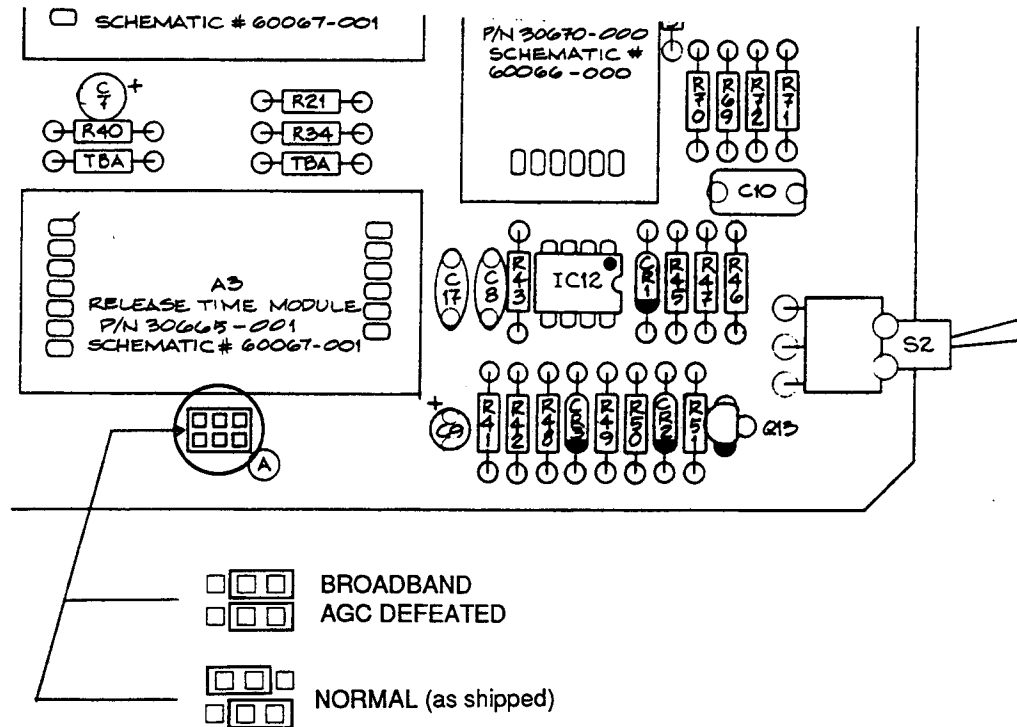


Fig. 2-3: Jumper Positions, Card #6

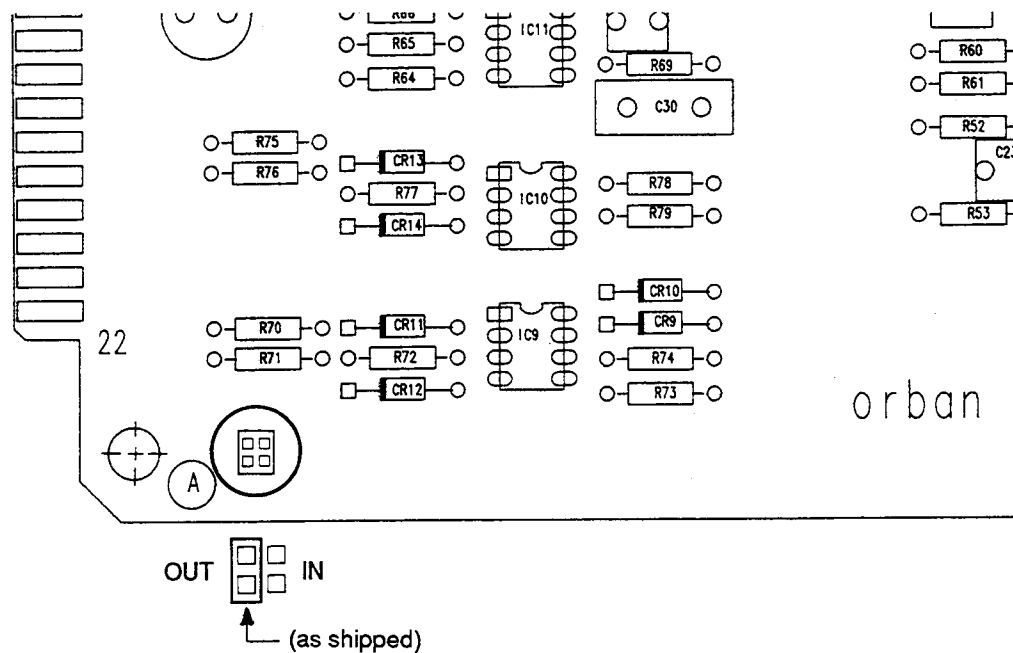


Fig. 2-4: Jumper Positions, Card #7

5) Close the front panel.

- ☐ A Replace the subpanel and tighten the four fasteners that hold it.

Taking care not to stress the flat cables beneath it, tilt the top of the subpanel inward and to the left to clear the upper chassis lip and the door support rail at the right. Be sure that all four fasteners on the subpanel are engaged, since the subpanel is an integral part of OPTIMOD-HF's RF shielding. (The DZUS fasteners turn only $\frac{1}{4}$ -turn; don't force them, lest they be damaged in a way that is very time consuming to repair.)

- ☐ B Raise the front panel and fasten the two screws that hold it in place.

6) Mount OPTIMOD-HF in a rack.

- ☐ A Mount the 9105A in a rack near the transmitter or phase-linear STL transmitter.

Relevant system considerations are discussed beginning on page 1-4.

Because OPTIMOD-HF has been carefully designed to operate in high-energy EMI environments, no special placement precautions are necessary. If possible, OPTIMOD-HF should be mounted away from sources of vibration (such as large blowers).

Equipment life will be lengthened if operated at moderate room temperatures and humidity, and if the air is reasonably dust-free and non-corrosive. Using some of the exhaust to heat the building slightly above ambient temperature is often sufficient to prevent problems. Never operate OPTIMOD-HF in ambient temperatures that exceed 50°C (122°F).



- ☐ B Verify that the resistance between the 9105A chassis and ground is less than 0.5 ohm.

It is important that the OPTIMOD-HF chassis be properly connected to a good earth ground. Wire is totally ineffective at VHF and above; the best way to ground the OPTIMOD-HF chassis is to mount it solidly in a rack connected to earth through a wide, thin copper ground strap.

In areas where electrical storms are frequent, it may be advisable to add suitable varistors between each incoming wire (AC, remote control, and audio) and a solid earth ground.



- ☐ C Connect the 9105A's circuit ground to the station's RF system ground.
- ☐ D Power the 9105A.

7) Connect input audio to the 9105A's INPUT terminals.

The 9105A's inputs are electronically balanced. Input impedance is 11.2K with the 20dB pads operative (-10dBu to +10dBu sensitivity), and 200K with the 20dB pad defeated (-30dBu to -10dBu sensitivity). The INPUT terminals are located on the rear panel.

(To change input sensitivity, see step 3 on page 2-7.)

OPTIMOD-HF should be fed unprocessed audio — no other audio processing is necessary or desirable.

If source requires 600-ohm termination: Connect the supplied 620-ohm $\pm 5\%$, $\frac{1}{4}$ -watt, carbon film resistor between the INPUT + and INPUT - terminals. (Telephone or post lines often require 600-ohm termination.)

In high-RF radiation fields: Run *balanced* audio to OPTIMOD-HF in 100% foil-shielded, twisted-pair cable (like Belden 8451). Connect the shield to chassis ground at *both* ends. (If the source signal is unbalanced, connect the INPUT - terminal to system ground.) Properly ground the telephone line termination box or STL receiver to earth.

In low-RF radiation fields: Run balanced audio in shielded cable with the shield connected to chassis ground at the *source end only*. Audio may be run unbalanced in a low-RF field if cable length is less than 20 feet (6 meters).

8) Connect the 9105A's output to the transmitter or STL.

A ☐ Connect the 9105A's output to your transmitter or STL.

The outputs of OPTIMOD-HF are electronically balanced and floating, simulating a true transformer. Output impedance is $30\Omega \pm 5\%$. Drive capability is +20dBm into 600Ω or +13dBm into 150Ω (the lowest permitted load impedance).

Treat the output exactly as you would treat a transformer-coupled output: Take the output between the + and - terminals, regardless of whether the load is balanced or unbalanced.

In high-RF radiation fields: Run *balanced* audio to OPTIMOD-HF in 100% foil-shielded, twisted-pair cable (like Belden 8451). Connect the shield to chassis ground at *both* ends.

In low-RF radiation fields: Run balanced audio in shielded cable with the shield connected to chassis ground at the *source end only*. Audio may be run unbalanced in a low-RF field, if cable length is less than 20 feet (6 meters).

B ☐ Test the equipment downstream from OPTIMOD-HF. (optional)

Set the 9105A's NORMAL/SQUAREWAVE switch to SQUAREWAVE. Set the FREQUENCY control to 1kHz, and advance the OUTPUT ATTEN as necessary to easily see the square wave. Verify that the waveforms at the input stage of the transmitter modulator do not exhibit evidence of overshoot or ringing that might have been introduced by the transmitter's input transformer and/or by resonance between the input transformer and the capacitance of the input cable.

If such problems are observed, it is sometimes possible to minimize them by placing a 300-ohm, $\pm 5\%$, $\frac{1}{4}$ -watt carbon resistor in series with each side of the input line to the transmitter. This may damp out ringing (but beware — it may also increase low-frequency distortion induced by the transformer). In other cases, the transmitter's input transformer may have been chosen without regard for its transient response (particularly in older transmitters designed before the advent of "modern audio processing"), and the input transformer may have to be replaced with a better

transformer or with an electronic differential amplifier. This may seem fussy, but every dB of overshoot is a dB of lost average modulation!



IMPORTANT

DO NOT place additional clipping devices (such as RCA's Powermax™ or Harris' Modulation Enhancer) *after* OPTIMOD-HF! The additional distortion introduced by these devices will totally nullify the advantages of OPTIMOD-HF's distortion-canceling clipper. Further, the harmonics that they create will destroy the rigorous band-limiting applied to the signal by OPTIMOD-HF. Be particularly aware that some transmitters contain built-in clippers, and that the drive level to the transmitter must be adjusted so that these clippers *never* operate.

9) Connect OPTIMOD-HF to your remote control system. (optional)

OPTIMOD-HF's OPERATE/BYPASS, PROCESSOR PRESET 1/2, and HF TX EQ PRESET can all be controlled remotely (momentary front-panel switches provide equivalent local control). Optically isolated remote control terminals are located on the rear panel.

Applying a 6-24V AC or DC pulse between the appropriate REMOTE terminal and the REMOTE COMmon terminal will select the desired function. The EQ COMmon terminal is the return for the EQ 0 through EQ7 terminals. The COMmon terminal is the return for the NORMAL/BYPASS and PROCESSOR PRESET 1/2 terminals. If DC is used, connect the - to the COMmon or EQ COMmon terminal and the + to the remote function terminals. If you use 48V, provide current limiting by connecting a 1K $\pm$ 10%, 2-watt carbon composition resistor in series with the COMmon terminal, and a 1K $\pm$ 10%, 2-watt carbon composition resistor in series with the EQ COMmon terminal.

If you wish to lock out the front-panel switches so that these functions can be set *only* by remote control, set the LOCKOUT switch to the DOWN position. This switch is mounted on the circuit board behind the left front panel, and can be seen to the left of the swing-down door when it is open.

Tallies are provided to indicate the status of the PROCESSOR PRESET and SYSTEM OPERATE/BYPASS logic. These are floating SPST relay contacts, and are available on the rear-panel barrier strip. Contacts are closed in PRESET 2 and SYSTEM BYPASS modes respectively. Limit applied voltage to 50V AC or DC, total load to 10VA non-reactive, current to 0.5A.

10) Equalize transmitter low frequency response.

OPTIMOD-HF equalizes the output signal to pre-compensate for tilt in the transmitter.

OPTIMOD-HF was designed to feed a single transmitter switched into many different antenna loads. Therefore, the OPTIMOD-HF transmitter equalizer has only one set of controls for low-frequency equalization (which is dependent on the transmitter, but not on the antenna), but eight remotely-selectable sets of controls, numbered 0-7, for high-frequency equalization (which is dependent on both the transmitter and the antenna load).

- A ☐ Open the door in the front panel.
- B ☐ Set the controls as shown in Fig. 2-5.

If no setting is specified, it is not important how the control is set.

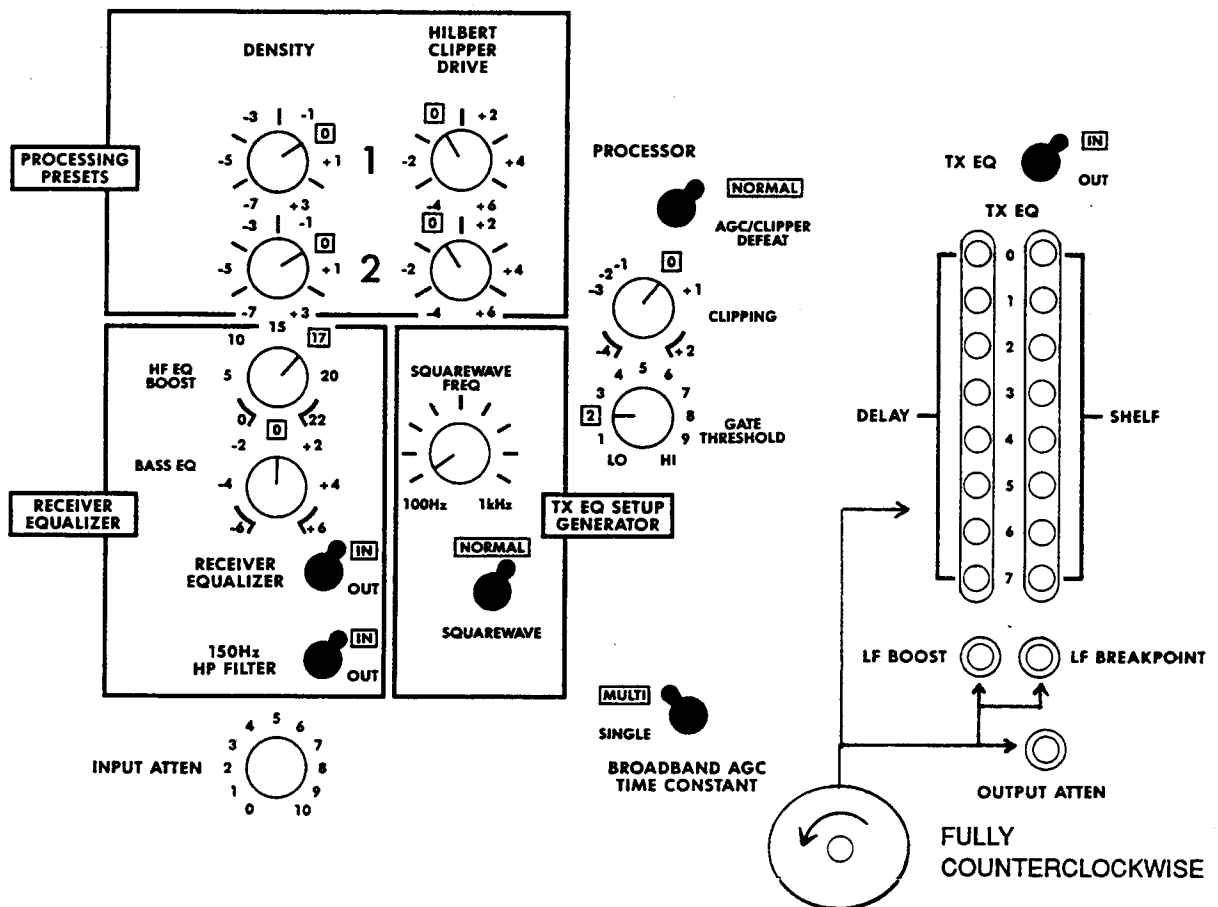


Fig. 2-5: Control Settings for Step 10-B

- c ☐ Connect the vertical input of the oscilloscope to the transmitter RF sample.
- d ☐ Connect a conventional scope probe to the external trigger (or sync) input of the oscilloscope. Connect the probe between the + audio output of OPTIMOD-HF and ⏏ to provide a signal to trigger the scope.

☐ E Turn the OUTPUT ATTENUATOR fully counterclockwise (may take up to 18 turns).

☐ F Set the TX EQ SETUP GENERATOR SWITCH to SQUAREWAVE, and set the SQUAREWAVE FREQUENCY control to 100Hz.

OPTIMOD-HF contains an internal square wave generator for this adjustment. The level of this generator is set for approximately 30% modulation, which should be low enough to prevent over-stressing any reasonably-designed transmitter.

The frequency of the generator is adjustable from 100 to 1000Hz, $\pm 30\%$. The calibration is very approximate because accurate frequency calibration is unnecessary to perform the following adjustments.

☐ G Turn on the carrier, and turn the OUTPUT ATTENUATOR control clockwise until the oscilloscope indicates that the carrier is being modulated about 30%.

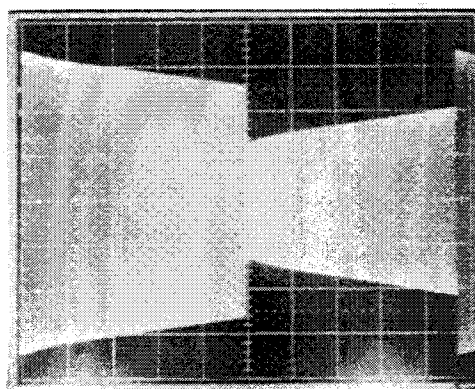
Synchronize the oscilloscope from its EXTERNAL SYNC INPUT.

If the oscilloscope display looks like that in Fig. 2-6(B), the transmitter does not require low frequency equalization. Skip to step 11.

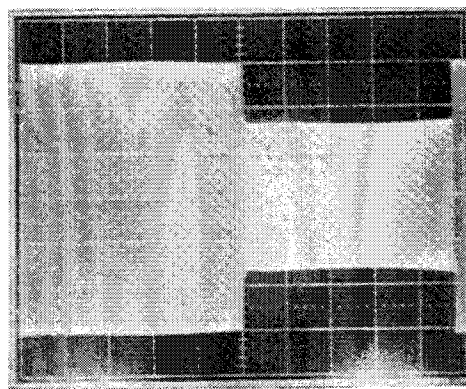
Most transmitters will produce an RF envelope resembling that shown in Fig. 2-6(A).

☐ H Turn the LF BREAKPOINT control clockwise until the square wave is as flat as possible.

Fig. 2-6(B) shows the result of a successful adjustment.



(WITHOUT TILT CORRECTION)



(WITH OPTIMUM TILT CORRECTION)

Fig. 2-6: Low-frequency Tilt Correction
(see step G)

If a display like that in Fig. 2-6(B) could not be produced by adjusting the LF BREAKPOINT control, transmitter low frequency response is inadequate — there is too much low-frequency roll-off.

Note that a transmitter which is not fully equalized can cost up to 4dB average modulation — although audible frequency response does not suffer because equalization occurs below the audible frequency range. This cannot be corrected without modifying the transmitter. In many

cases, such modification is easy: it merely requires bypassing the high-pass filter(s) in the input stage of the transmitter. It also may require replacing coupling capacitors with capacitors with larger value. In other cases, fundamental inadequacies in the input, inter-stage transformers (if used), and/or modulation transformers (if used) are the cause. See the discussion on page 1-6.

☐ Adjust the LF BOOST control. (optional)

Some transmitters cannot be fully corrected because the bass boost produced by the equalizer exaggerates power supply bounce problems and/or causes actual saturation or clipping of modulator stages, transformers, reactors, etc. (see page 1-6). In some cases, a compromise between full tilt correction and these other problems may have to be achieved by careful experimentation with program material. The 9105A's LF BOOST control is designed to permit such a compromise.

The preceding transmitter equalization adjustment was done using the *maximum* low-frequency boost to ensure response that is closest to true DC-coupling, and thus optimize square wave response. If this large amount of boost at sub-audible frequencies causes bounce and/or distortion on heavy bass transients in music, turn the LF BOOST control counterclockwise until these problems are no longer observed. This will make the measured square wave response *poorer*. However, engineering realities force a compromise between best *small signal* (i.e., square wave) response and best *large signal* (i.e., bounce and distortion) performance. This compromise is best made by careful experimentation with program material to find the setting of the LF BOOST control that gives the highest average modulation without audible distortion.

If the tilt correction trips overload relays when program material is broadcast, it is often possible to readjust the trip point of these relays to avoid this problem — but do this with the greatest care, because the transmitter will be endangered by an improperly adjusted overload relay.

Orban *accepts no responsibility* for transmitter failures introduced by such re-adjustments, or by the high average power, bass and treble pre-emphasis, or by any other characteristics of OPTIMOD-HF audio processing.

The care and feeding of your transmitter requires the application of sound engineering judgment: inadequate transmitters may fail, may have their tube life shortened, etc. Such transmitters are simply incapable of supplying the average *power demands* of OPTIMOD-HF processing — regardless of transmitter equalization. If the station is to achieve the full benefits of OPTIMOD-HF processing, these transmitters must be either repaired, modified, or replaced.

11) Equalize transmitter/antenna high-frequency response.

OPTIMOD-HF equalizes the output signal to pre-compensate for overshoot and ringing in the transmitter's output stage and in the antenna system. Since the pre-compensation may vary from antenna to antenna and from frequency to frequency, OPTIMOD-HF has eight remotely-selectable sets of controls, numbered 0–7, for high-frequency equalization. The 9105A powers up with the PRESET 0 high-frequency equalization active.

- A ☐ Toggle the front-panel TX EQ switch until the numeric display shows the number of the equalizer preset that you want to adjust.
- B ☐ Connect the transmitter to the antenna load that you want to equalize with this equalizer preset.

This adjustment *cannot* be done into a dummy load.

- C ☐ Set the SQUAREWAVE FREQUENCY control to 1kHz. Readjust the timebase of the scope as necessary to easily see the modulation.

The transmitter should still be producing approximately 30% modulation.

(NOTE: If you look at the squarewave at the output of OPTIMOD-HF, you will see that it has a very small amount of ringing. This is due to its being passed through a filter in OPTIMOD-HF located after the squarewave generator. The dominant frequency of the ringing is above the expected passband of the transmitter and antenna system, and this ringing will not in any way affect the accuracy of the following adjustment.)

- D ☐ Adjust the SQUAREWAVE FREQUENCY control so that any ringing or overshoot observed on the modulated RF envelope has time to settle completely within each cycle of the square wave.

If no ringing or overshoot is observed, proceed to adjustment of the next preset. When all presets are adjusted, skip to step H.

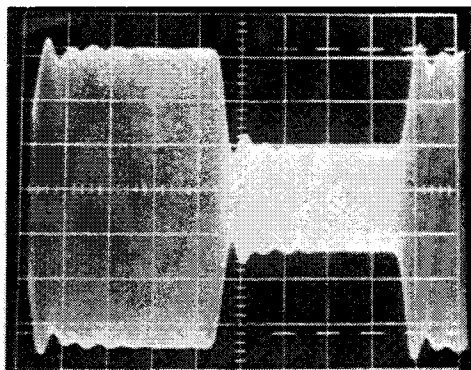
- E ☐ There are eight sets of DELAY EQ and SHELF EQ controls, numbered 0 through 7. Adjust the appropriate DELAY EQ and SHELF EQ controls to minimize ringing and overshoot.

The DELAY EQ and SHELF EQ controls interact. First, adjust the SHELF EQ control until any ringing is reduced to the same level as the flat part of the square wave (you will still see ringing, but no *overshoot*). Then adjust the DELAY EQ control (which will further reduce the amplitude of the ringing on the *leading* edge of the square wave while introducing a new ring on the *trailing* edge) until the amplitude of the ringing at the leading and trailing edges is equal. The peaks of the ringing at both edges should approach the flat-top modulation level as closely as possible *without exceeding it*.

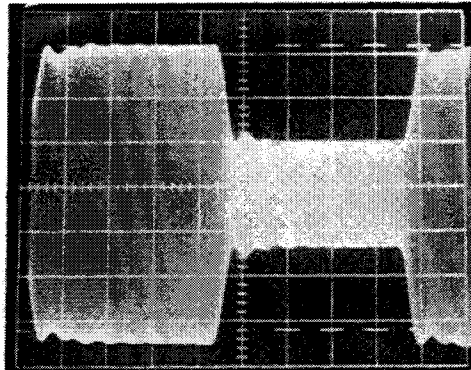
Adjusting the DELAY EQ control like this usually reduces the level of the ringing to *below* the flat-top modulation level. Reducing the setting of the SHELF EQ control until the ringing is again at the flat-top modulation level will unbalance the ringing at the leading and trailing edge of the square wave, and necessitate further adjustment of the DELAY EQ control. Alternate between these two *interactive* controls until the peaks of ringing at both the leading and trailing edges of the square wave are at the flat-top modulation level. Fig. 2-7 illustrates a typical waveform before and after adjustment (the waveform produced by your system may look quite different).

- F ☐ Make a quick sweep through the entire range of the SQUAREWAVE FREQUENCY control.

If you have correctly adjusted the LF BREAKPOINT, LF BOOST, DELAY EQ and SHELF EQ controls, the waveform should not exceed the steady-state, flat-top modulation level of the square wave at any frequency.



(WITHOUT CORRECTION)



(WITH OPTIMUM DELAY AND SHELF CORRECTION)

Fig. 2-7: High-frequency Overshoot and Ringing Correction
(see step E)

- ☐ *If you are using other EQ presets, repeat steps A through F for each EQ preset you will use.*

If the transmitter is ordinarily switched into more than eight different combinations of frequency and load, it is usually easy to define several "compromise" settings that work well for more than one combination.

- ☐ Turn off the carrier.

12) Set audio processing controls.

The control settings recommended in this step should produce a loud, highly intelligible sound that sounds undistorted on a typical portable or tabletop shortwave radio. Use these settings as a starting point — Section 3 will explain how to adapt the settings to your taste, format, and target audience.

There are two DENSITY and two HILBERT CLIPPER DRIVE controls. These are selected by the PROCESSOR PRESET 1/2 switch on the front panel, or by remote control. These controls can be set for two different types of programming (like speech, and speech interspersed with music), and selected at any time.

- ☐ Set the 9105A's controls as shown in Fig. 2-8.
- ☐ Turn the OUTPUT ATTENUATOR fully counterclockwise (this may take up to 18 turns).

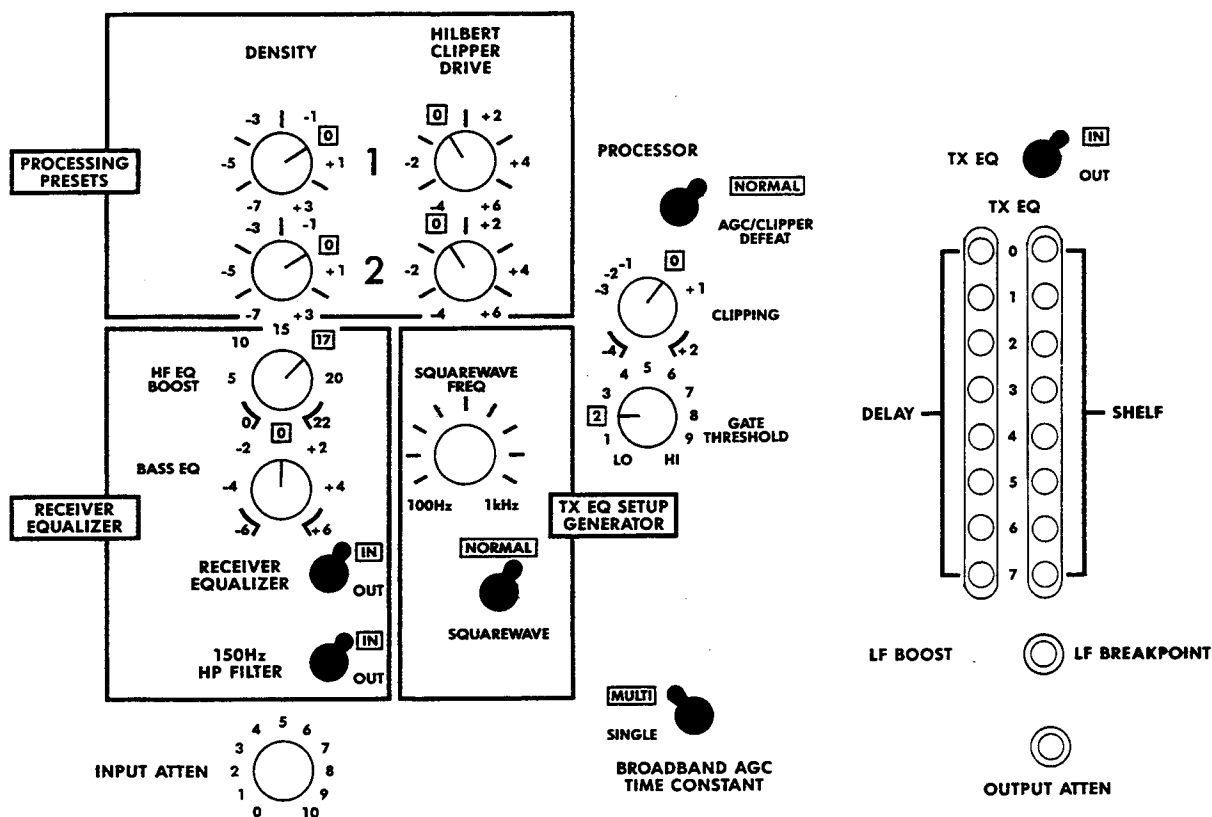


Fig. 2-8: Control Settings for step 12-B

- c ☐ Drive the 9105A with a 1kHz tone at your normal reference level.

This will ordinarily be "0VU" (in a VU meter-based plant) or 8dB below normal peak operating level (in a PPM-based plant).

- d ☐ Adjust the INPUT ATTENUATOR control until the BROADBAND AGC G/R meter reads 0dB.

0dB on the meter corresponds to 10dB gain reduction. If the INPUT ATTEN control will not adjust the meter to this level, you may need to change the input attenuation option (see step 3).

If you do not wish to use a tone, drive the 9105A with program material and adjust the INPUT ATTENUATOR control until the BROADBAND AGC G/R meter reads 0dB on the average. (This method is also completely satisfactory because the drive level to the 9105A is not at all critical — it was *designed* to compensate for variations in input level.)

If you are using a level controller like Orban's 464A "Co-Operator" Compressor/Limiter/High-Frequency Limiter/Clipper to protect the STL, you should have already defeated the 9105A's broad-band AGC according

to step 4-A on page 2-8 (the level controller now performs the function of the 9105A's broad-band AGC.) With the 9105A's broad-band AGC defeated, its BROADBAND AGC G/R meter will always read 0. Because no AGC will occur, it is important to set the 9105A's INPUT ATTENUATOR controls low enough to avoid clipping the broad-band AGC VCA, which is still in the circuit even though its control circuitry has been defeated. To avoid clipping, set the 9105A's INPUT ATTENUATOR controls so the 9105A's VU meter never exceeds -6VU when the selector switch is set to AGC.

- Ε ☐ Apply program material to the 9105A's input at normal operating levels.

The GATE lamp should light during pauses in the program, and the BROADBAND AGC G/R meter should "freeze" (during a very long pause, it will slowly drift to 0dB).

- F ☐ Turn on the carrier.

- G ☐ Observe the oscilloscope. Adjust the OUTPUT ATTN control to achieve as high peak modulation as possible without carrier pinch-off.

If all is well, the negative peaks of the envelope modulation will usually "hang" close to 100% at all times except during pauses. If the correct adjustment of the OUTPUT ATTENUATOR control seems dependent on the nature of the program material, the transmitter probably suffers from power supply bounce. See step 10-I on page 2-15.

To achieve highest possible modulation without carrier pinch-off (and therefore most efficient utilization of available transmitter power), the OUTPUT ATTN control *must* be adjusted with program material (not test tones), because the transmitter will almost always behave somewhat differently with program material than with tone. For example, tone cannot excite power supply bounce.

Once an adjustment has been made for a given transmitter, it may be possible to devise a tone set-up procedure *for that particular transmitter*. For reference, when OPTIMOD-HF's diagnostic VU meter reads 100% in the H-T CLIPPER and TX EQ positions with a 1kHz sine wave, then the tone is at OPTIMOD-HF's internal 100% peak modulation limit. Given an *ideal* transmitter, it would be correct to set the 9105A's OUTPUT ATTN to produce 100% modulation of the carrier. However, because of transmitter inaccuracies, a compensation factor must be experimentally developed for each transmitter. To do this, adjust the OUTPUT ATTN with program material to achieve highest modulation without pinch-off. Then apply a tone to the 9105A's input. Switch the PROCESSOR NORMAL/BYPASS switch to BYPASS. Adjust the oscillator so that the 9105A's VU meter reads 100% in the TX EQ position. Note the percentage modulation (as indicated on your modulation monitor). Call this "x"%. Future adjustments would then be made by making the 9105A's VU meter read 100% in the TX EQ position with a 1kHz tone, and then adjusting the 9105A's OUTPUT ATTN to produce "x" % modulation of the carrier. Because transmitters drift with time (as components age), and even as mains voltage changes, such a scheme is not likely to be as successful as simply monitoring the modulation with normal programming, and adjusting the 9105A's OUTPUT ATTN if it becomes necessary to correct modulation levels because the transmitter has drifted.

13) Install Monitor Roll-Off Filter(s). (optional)

The Monitor Roll-Off Filter alters the flat response typical of a modulation monitor's audio output to one that more closely resembles that of an actual shortwave receiver. (See page 1-11 for more about studio monitors.)

The output of the Monitor Roll-Off Filter simulates the sound of an "average" shortwave radio whose -3dB frequency is 2.0kHz, and which rolls off at 18dB/octave thereafter. It is designed to match the GREEN pre-emphasis module installed on Card #4. (For more about the various pre-emphasis modules, see page 3-13.) The amount of roll-off is adjustable with the HF ROLLOFF control to complement the setting of the HF EQ control on the 9105A.

Alternately, a fixed 6dB/octave roll-off that complements the BLUE pre-emphasis module can be selected with jumpers (see the drawing on page 6-70 for jumper positions). The 6dB/octave roll-off closely matches a "standard" receiver using the North American National Radio Systems Committee (NRSC) pre-emphasis standard. This standard is quite wide-band compared to an "average" shortwave radio, and would not tend to accurately simulate it.

The HF ROLLOFF control on the Monitor Roll-Off Filter is inactive when this option is selected.

- A ☐ Connect the audio output of your modulation monitor to the INPUT terminals of the Monitor Roll-Off Filter.

If the output impedance of the source is between 0 and 35 ohms (such as the output of an opamp), connect the source between the 0-OHM SOURCE and COM terminals on the roll-off filter chassis.

If the output impedance of the source is 600 ohms, connect the source between the 600-OHM SOURCE and COM terminals.

If the output impedance is some value in between, connect a resistor between the source's output and the Monitor Roll-Off Filter's 600-OHM SOURCE terminal so that the total source impedance seen by the Monitor Roll-Off Filter is 600 ohms (external resistor+output impedance of source=600 ohms).

- B ☐ If your console monitor or monitor amplifier input is bridging (like most modern amplifiers), set the TERMINATION switch on the roll-off filter to ON.

If the console monitor or monitor amplifier input impedance is 600 ohms, set the TERMINATION switch to OFF.

- C ☐ Connect the input of your console monitor or monitor amplifier to the OUTPUT terminals on the Monitor Roll-Off Filter.

- D ☐ Connect the  terminals on the roll-off filters to earth ground for shielding.

The chassis ground is not connected to the COM terminals to avoid potential ground loops.

14) Verify audio quality of air sound.

Listen to the air sound on a good monitor system (and on actual receivers) to verify that it sounds natural and free from noise and distortion.

As set up according to the recommended settings, the audio should sound very clean on average radios. Slight clipping distortion may be perceived on high-quality monitors.

If the DENSITY, CLIPPING, or HILBERT CLIPPER DRIVE controls are advanced beyond our recommended settings, the sound will start to become audibly distorted, but average modulation will also increase. Average modulation and coverage must be traded-off against distortion according to the subjective tastes and desires of your organization. Section 3 of this manual provides guidance on how to most effectively make such trade-offs.

15) Check occupied bandwidth (optional)

Connect an RF spectrum analyzer to the monitor tap at the transmitter common point. Verify that the occupied bandwidth meets the standards of the relevant authorities in your country (such as the CCIR, EBU, or FCC).

The output of OPTIMOD-HF comfortably meets such standards when connected to an ideal transmitter. (If the spectrum falls off steeply at the edge of the passband but the passband extends to the wrong frequency, be sure that you have ordered OPTIMOD-HF with the correct low-pass cutoff frequency.)

The most likely cause of excessive occupied bandwidth is the transmitter. Over-modulation can cause the occupied bandwidth to enlarge rapidly — verify on an oscilloscope that no carrier pinch-off is occurring. If it is, reduce the drive to the transmitter with OPTIMOD-HF's OUTPUT ATTENUATOR control.

Distortion in the transmitter can also cause occupied bandwidth to increase. Such distortion will be detected with conventional harmonic and intermodulation distortion tests. If the transmitter seems to be operating as well as is expected for its type, it may be unable to handle the high average power in the OPTIMOD-HF output. In this case, occupied bandwidth can usually be controlled by slightly reducing modulation with OPTIMOD-HF's OUTPUT ATTENUATOR control.

While unlikely, excessive out-of-band energy at the output of OPTIMOD-HF itself could be caused by misadjustment of R106 (GAIN TRIM) in the Hilbert-Transform clipper (on Card #5). If R106 is set too far clockwise, the Hilbert-Transform clipper can overdrive OPTIMOD-HF's safety clipper and cause this problem. If a spectrum analyzer at OPTIMOD-HF's output shows that the audio spectrum is not controlled to the standards of your governing authority, extend Card #5, following the instructions on page 4-6 to access the card cage. (Be sure to turn off AC power before removing or replacing any circuit card.) Mark the initial setting of R106 with a pencil. Then turn it slightly counterclockwise until the spectrum is satisfactorily controlled. (This should only take a very slight adjustment. If the high frequency spectral energy does not decline very rapidly as the control is turned, the problem is probably elsewhere in the system. If you cannot locate the problem by following the troubleshooting procedure in Part 5 of this manual, please contact Orban customer service — see page 5-14.)

16) Complete the Registration Card and return it to Orban.
(please)

The Registration Card enables us to inform you of new applications, performance improvements, and service aids which may be developed, and it helps us respond promptly to claims under warranty without having to request a copy of your bill of sale or other proof of purchase. Please fill in the Registration Card and send it to us today. (If it is lost, use the duplicate on page 1-13.)

We do not sell our customers' names to advertising agencies.

Section 3

Operation

page contents

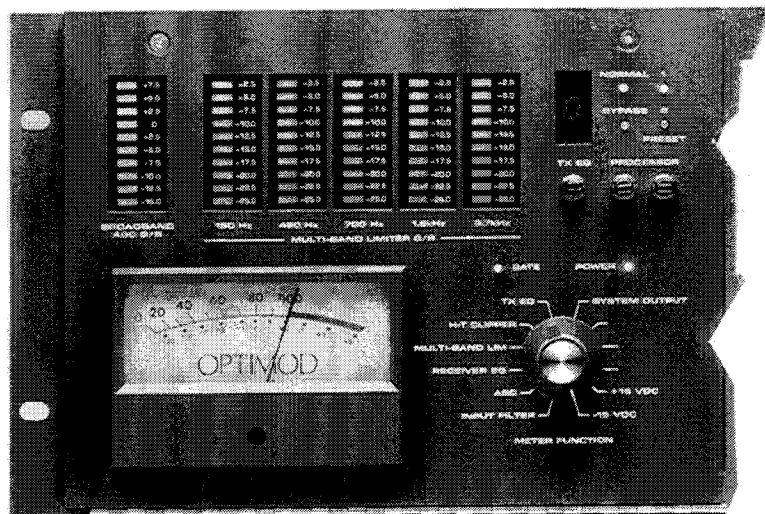
3-2	OPTIMOD-HF Controls and Meters
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CAUTION



The installation and servicing instructions in this manual are for use by qualified personnel only. To avoid electric shock do not perform any servicing other than that contained in the Operating Instructions unless you are qualified to do so. Refer all servicing to qualified service personnel.

OPTIMOD-HF Controls and Meters



BROAD-BAND AGC G/R meter indicates the amount of gain reduction being applied by the broad-band AGC. 0dB on this meter corresponds to 10dB gain reduction.

MULTI-BAND LIMITER G/R meters indicate the amount of gain reduction being applied to each frequency band by the multi-band limiter. When these meters read 0dB, no gain reduction is occurring.

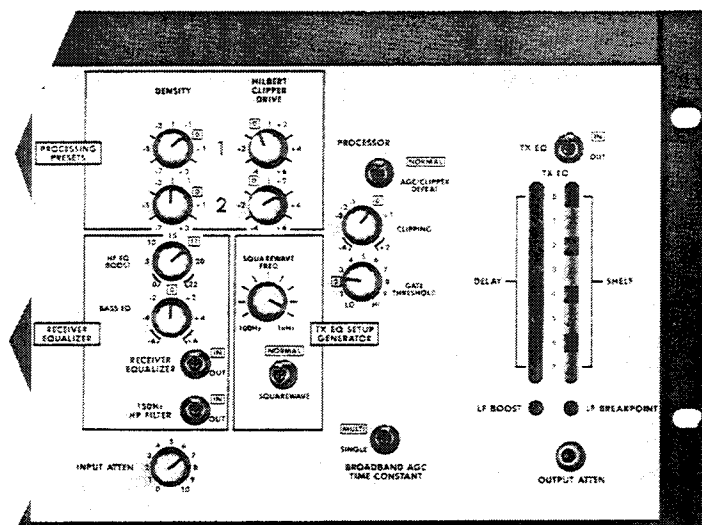
TX EQ PRESET switch steps upward through eight independent sets of transmitter high-frequency equalization controls (marked 0 through 7). The selection can be made with this momentary-contact switch or through remote control terminals on the rear panel. OPTIMOD-HF powers up with PRESET 0 equalization active.

PROCESSOR PRESET switch switches the 9105A from PRESET 1 to PRESET 2. This selects one of a pair of DENSITY controls and one of a pair of HILBERT CLIPPER DRIVE controls to permit presetting the processor's "sound" for two different types of program material or propagation conditions. (These presets have nothing to do with the TX EQ presets.)

PROCESSOR NORMAL/BYPASS switch permits most of the circuitry in the 9105A to be bypassed. The 50Hz high-pass filter, the low-pass filter (usually 4.5kHz unless ordered otherwise), and the final protection clipper are retained in the circuit to protect the transmitter from accidental application of inappropriate audio levels or frequencies during test.

PANEL LOCKOUT switch (located just to the left of the swing-down door, on the circuit board behind the front panel) when set OFF (in the downward position), defeats the TX EQ PRESET, PROCESSOR PRESET, and PROCESSOR NORMAL/BYPASS switches on the front panel. The FRONT-PANEL LOCKOUT switch is useful to prevent problems due to accidental local operation of a switch when the plant is being operated by remote control.

GATE lamp lights when the input audio level falls below the threshold set by the GATE THRESH control. When this happens, the AGC's recovery time is drastically slowed to prevent noise rush-up during low-level passages.



VU meter and selector switch display signal levels at various points in the circuitry to aid in diagnosing faults (see Block Diagram on page 6-47). The meter also displays +15V and -15V power supply voltages (100% corresponds to 15VDC).

DENSITY controls determine how hard the multi-band limiter is driven, and therefore how much the limiter will increase the density (short-term average power) and loudness of the audio. There are two DENSITY controls, selected by the PROCESSOR PRESET 1/PROCESSOR PRESET 2 logic. (OPTIMOD-HF can be switched from PRESET 1 to PRESET 2 by the front-panel PROCESSOR PRESET momentary toggle switch, and by remote control.) **EQ IN/OUT switches** enable or defeat the program equalization controls (HF EQ BOOST, BASS EQ, 150HZ HIGH-PASS FILTER) for the corresponding channel. The program equalizer is located prior to any AGC, limiting, or clipping circuitry.

HF EQ controls boost high-frequency audio by 0 to 22dB. The shape of the boost curve is determined by the pre-emphasis module on Card #4.

BASS EQ control equalizes bass audio by up to ± 6 dB. The equalizer creates a bell-shaped curve with a Q of 0.7 and a center frequency of 100Hz.

150Hz HP FILTER switch activates or defeats a 6dB/octave high-pass filter with a -3dB frequency of 150Hz. The filter is prior to limiting and clipping.

INPUT ATTN controls adjust the signal level driving the broad-band AGC. This level determines the relative amount of gain reduction in the broad-band AGC, and therefore the amount of compression and the increase in the loudness of quiet program material.

HILBERT CLIPPER DRIVE determines the drive level to the Hilbert Transform Clipper, and thus how much clipping will be produced by this circuit. This control is the primary means of determining the tradeoff between average modulation (loudness) and distortion. A pair of controls, switchable with the PROCESSOR PRESET 1/2 switch, is provided to permit two presets for different program material or propagation conditions.

SQUAREWAVE FREQUENCY determines the frequency of the built-in square wave generator that is used to set up the transmitter equalizer controls. Range is approximately 100-1000Hz, $\pm 30\%$.

NORMAL/SQUAREWAVE switch turns on the built-in squarewave generator. Note that it *does not shut off the normal audio*. To prevent normal audio from mixing in with the squarewave, input audio must be suppressed when making measurements that use the squarewave generator.

PROCESSOR switch is used for testing the circuitry within OPTIMOD-HF. When set to AGC/CLIPPER DEFEAT, it disables clipping and overrides normal gain reduction control, but does not bypass any active circuitry. (In contrast, the front-panel NORMAL/BYPASS switch physically bypasses most of the processing circuitry, and is used to facilitate testing of the transmitter.)

CLIPPING control adjusts signal level going into the multi-band distortion-canceling clippers, and therefore determines the amount of peak limiting accomplished by multi-band distortion-canceling clipping. Range is -4dB to +2dB (where 0dB represents our judgment of a setting that provides a high-quality "undistorted" sound without compromising loudness or modulation efficiency). This control can usually be safely set at "0", because the loudness/distortion trade-off is primarily determined not by this control, but by the HILBERT CLIPPER DRIVE control.

GATE THRESH control determines the lowest input level that the system considers program. Levels below this are considered noise, and the broad-band AGC gates, freezing its gain to prevent noise breathing during pauses or low-level passages.

TIME CONSTANT switch, when set to SINGLE, causes the broad-band AGC to operate with very slow attack and release time (best for music or mixed voice and music). When the switch is set to MULTI, attack and release times are speeded up (best for material with widely varying levels, such as talk or location audio).

TX EQ IN/OUT switch enables or defeats the transmitter equalization controls (LF BREAKPOINT, LF BOOST, DELAY EQ, SHELF EQ).

LF BREAKPOINT controls sets the frequency at which the response of the tilt equalizer is up approximately 3dB.

LF BOOST controls determines the maximum amount of low-frequency tilt equalizer correction.

SHELF EQ controls sets the frequency at which the high-frequency shelving equalizer begins to roll off the high-frequency response to compensate for overshoot in the transmitter/antenna system.

DELAY EQ controls sets the frequency at which the delay equalizer begins to add phase shift to correct for non-constant delay in the transmitter/antenna system.

OUTPUT ATTEN control adjusts the level of the output signal, and thus the modulation level of the transmitter.

Recommended Settings for the Best Sound

The 9105A OPTIMOD-HF offers versatile, wide-range set-up controls to enable you to customize the subjective “sound” of the processing to fit your goals. These goals are likely to be quite different than they would be in MW, LW, or VHF broadcast, because listeners to HF broadcasts are often highly motivated, and will continue to listen even when the signal is severely degraded by poor propagation conditions or by interference that would almost certainly cause the average LW, MW, or VHF listener to tune to another station.

In LW and MW, the audio processor set-up controls are usually used to match the processor’s “sound” to a certain type of music or talk programming. HF is different. In HF, the audio processor is usually adjusted to provide an sound at the receiver that is as esthetically satisfying as possible, *given the probable signal quality at the receiver*. The broadcasting organization usually does not have the luxury of making fine adjustments to match different types of program material, because such fine adjustments will almost certainly be masked by the variability of the propagation and interference experienced by the listener. This fact considerably simplifies the adjustment procedure.

Our “recommended initial settings” are shown on OPTIMOD-HF’s control panel as markings surrounded by squares. Setting the controls to these squares provides a good, although somewhat conservative, starting point that is satisfactory for both voice and music. Advancing the DENSITY, HILBERT CLIPPER DRIVE, or CLIPPING controls beyond these settings is likely to introduce audible distortion on high-quality studio monitors. However, in the real world, propagation conditions or interference may entirely mask this distortion at the receiver, and the overall perceived quality is likely to improve due to increased signal-to-noise ratio.

When the program consists solely of speech, it is usually possible to advance the DENSITY and CLIPPING controls substantially. If the signal-to-noise ratio at the receiver is very good, the listener may perceive some distortion. However, if conditions are not ideal, intelligibility will increase because the various components of speech will be more easily heard over noise and interference. Further, a small amount of clipping distortion is usually not objectionable in the context of the frequent severe distortion induced in receivers’ envelope detectors by selective fading.

Because the appropriate settings for music/speech programming may be more conservative than the appropriate settings for speech-only programming, OPTIMOD-HF offers two presets for the DENSITY and HILBERT CLIPPER DRIVE controls. These might be set for music/speech and speech-only, or for two different sets of propagation conditions — one “loud and clear”, and one where reception is plagued by noise and interference.

To become familiar with the subjective effect of the controls, start with the “conservative” recommended settings marked on the control panel. Spend some time listening critically to your on-air sound. Listen to a wide range of program material typical of your programming, and listen on several types of radios (not just on your studio monitors). Then, if you wish to customize your sound, read the rest of Section 3 — it is important to understand the functions and interactions of the audio processing controls before experimenting with them.

Getting the Sound You Want

In any audio processor, there is a *direct trade-off* between loudness, brightness, and distortion. You can improve one only at the expense of one or both of the other two. Perhaps the most difficult part of adjusting a processor is determining the best trade-off for a given situation. The situation in HF broadcast is special because the signal is often severely degraded by propagation and interference effects by the time it gets to the receiver. In most cases, we recommend that the processor be adjusted for high loudness, even if it produces a slight amount of audible distortion. The improvement in intelligibility at the receiver will often justify this trade-off.

Working Together

Best results will be achieved if Engineering, Programming, and Management go out of their way to *communicate* and *cooperate* with each other. It is important that Engineering understand well the sound that Programming desires, and that Management fully understand the trade-offs involved in optimizing one parameter (such as loudness) at the expense of others (such as brightness or distortion). If a producer is accustomed to listening to the signal through a high-quality monitor, it is particularly important that he or she hears and understands how the program sounds when subject to typical HF propagation degradations, since this understanding may completely change his or her opinion regarding the amount of audio processing that is appropriate.

Listening

A high-quality monitor system is essential. To modify your air sound effectively, you must be able to *hear* the results of your adjustments. We suggest you read the Orban publication, *Audio Quality in the AM Plant* (supplied), which contains a detailed discussion of how to efficiently create an accurate monitoring environment (and otherwise bring the audio plant up to state-of-the-art quality).

The response curve of the monitor system is as important as its quality. Because the studio monitor typically has a flat response, and because OPTIMOD-HF's output is ordinarily significantly pre-emphasized, the sound that emerges from the monitor would be shrill and unpleasant if the supplied Monitor Roll-Off Filter were not installed prior to the monitor amplifier.

The response of this filter is complementary to the frequency response of the GREEN receiver equalizer module (see page 3-12). Because the filter shelves-off at high frequencies (to match the receiver equalization) instead of continuing to roll off like a real radio, the monitor will sound somewhat brighter than will a real radio and cannot be used to make final subjective adjustments of the OPTIMOD-HF set-up controls. Nevertheless, it is completely suited as a reference for assessing quality, as it *will* clearly reveal distortion and other problems that may arise in the plant (see page 1-11).

It is misleading to rely on your monitor alone for subjectively evaluating your air sound. It is wise to develop a set of "reference radios" with which you are familiar, and which are similar to those used by a majority of your audience. Too often, just

one radio is used to evaluate air sound — but unless all of your listeners just happen to have the same radio, this approach will not give an accurate indication of what your audience is hearing. Based on their high-frequency response, HF radios can be divided into three groups:

1. Dual-bandwidth radios, in which the “wide-band” mode provides significant response to almost 5kHz.
2. Radios with a response down 3dB at approximately 2kHz, with a gentle roll-off above that frequency. Because the roll-off is gentle, pre-emphasis is effective in brightening the sound.
3. Radios with a response down 3dB at approximately 2kHz, with a very steep roll-off above that frequency. The steepness of the roll-off minimizes any improvement that pre-emphasis will make to the audio. Very few people would enjoy listening to music on these radios. However, their high selectivity is sometimes useful to listen to speech-only programs in the presence of substantial interference.

The vast majority of present-day radios are in the second and third categories. In all three types of radio, bass performance is completely unpredictable from model to model.

Be aware that many radios produce excessive distortion all by themselves, especially if they are located near the transmitter. If the station monitor (driven through OPTIMOD-HF's Monitor Roll-Off Filter) sounds clean but your radio audio is distorted, don't trust the radio!

More About Audio Processing

[Whether or not you have started with our “Recommended Initial Settings”, it is still wise to read the following section in detail. OPTIMOD-HF's full power will be available to you only if you understand the processor well.]

Psychoacoustic factors were carefully considered during the design of OPTIMOD-HF. The result is an audio processor that is easy to use (controls are limited to their *useful* ranges), and that produces a sound which is remarkably free of unwanted processing artifacts.

Although the controls on the 9105A provide the flexibility you need to customize your station's sound, proper adjustment of these controls consists of balancing the trade-offs between loudness, density, brightness, and audible distortion. The following provides the information you need to adjust the 9105A controls to suit your programming and target audience.

Some audio processing concepts.

Loudness and coverage are increased by reducing the peak-to-average ratio of the audio. If peaks are reduced, the average level can be increased within the permitted modulation limits. The effectiveness with which this can be accomplished without introducing objectionable side effects (like clipping distortion) is the single best measure of audio processing effectiveness.

Density is the extent to which the short-term rms amplitude of audio signal is made uniform (at the expense of dynamic range). Programs with large amounts of short-term dynamic range have low density; highly compressed programs have high density.

Compression reduces the difference in level between the soft and loud sounds to make more efficient use of permitted peak level limits, resulting in a subjective increase in the loudness of soft sounds. It *cannot* make loud sounds seem louder. Compression reduces dynamic range relatively slowly in a manner similar to "riding the gain"; limiting and clipping, on the other hand, reduce the short-term peak-to-average ratio of the audio.

Limiting increases audio density. Increasing density can make loud sounds seem louder, but can also result in an unattractive, busier, and less dynamic sound when reception conditions are good. On the other hand, in the presence of substantial noise, processing for high density improves intelligibility because those low-energy parts of the speech waveform that would ordinarily be reproduced below the noise level are instead amplified so that they can be heard. Thus highly dense program material can sound either good or unattractive, depending only on reception conditions!

Clipping sharp peaks does not produce any audible side effects when done moderately. Excessive clipping will be perceived as audible distortion. As in the case of highly dense speech, program material that is clipped to the point of sounding audibly distorted will often become noticeably more intelligible than undistorted speech in the presence of high noise or interference.

Loudness and density.

The amount of **gain reduction** determines how much the loudness of soft passages will be increased (and, therefore, how consistent overall loudness will be). The broad-band automatic gain control (AGC) and the multi-band limiter both provide gain reduction, although their effects are quite different.

The broad-band AGC is designed to control average levels, and to compensate for a reasonable amount of operator error. It is *not* designed to substantially increase the short-term program density (the multi-band limiter and distortion-canceling multi-band clippers do that). The amount of gain reduction produced by the broad-band AGC is controlled both by the setting of the INPUT ATTEN controls and by the level at which the console VU meter or PPM is peaked. (Because OPTIMOD-HF has been designed to work best with a nominal broad-band AGC gain reduction of 10dB, the BROAD-BAND AGC G/R meter is calibrated so that 0 on the meter corresponds to 10dB gain reduction.)

The attack and release times of the broad-band AGC are set with the TIME CONSTANT switch. When this switch is set to SINGLE, the broad-band AGC operates with very slow attack and release time. The SINGLE setting gives a more natural sound for music. When the TIME CONSTANT switch is set to MULTI, attack times are speeded up on transients which significantly exceed the average program level, and release times

are made faster momentarily after a transient. These attack and release characteristics are best for material with widely varying levels, such as round-table talk shows or location audio. Because the MULTI setting will produce slightly less musical solidity than the SINGLE setting, use it only if wide input level variations are inevitable and frequent.

The DENSITY controls determine how hard the multi-band limiter is driven. To achieve the density needed to achieve high speech intelligibility in the presence of noise, the multi-band limiter should be driven hard enough to produce about 10-15dB gain reduction in the middle bands. At this level, relatively few audible side-effects will be introduced. But be careful not to set the DENS controls too high, as this can cause an apparent increase in background noise, excessively loud breath sounds, "lispings" (caused by extreme high-frequency limiting of vocal sibilance), and increased clipping distortion. Clipping distortion can also be caused by setting the CLIPPING or HILBERT CLIPPER DRIVE controls too high. (There are two DENSITY controls, switched by the momentary PROCESSOR PRESET switch on the front panel, or by remote control.)

The CLIPPING control adjusts the signal level going into the multi-band distortion-canceling clippers. Its setting is reasonably non-critical, and we recommend leaving it at "0".

The Hilbert-Transform clipper in OPTIMOD-HF is a complex analog computer that simulates an radio-frequency (RF) clipper, but with substantially reduced intermodulation distortion below 2kHz. Like an RF clipper, its action introduces intermodulation distortion but no harmonic distortion. On speech, the ear finds harmonic distortion to be more offensive than intermodulation distortion. Thus, for the same amount of perceived distortion, *speech* can be clipped substantially harder with the Hilbert-Transform clipper than it could with a conventional "hard" audio-frequency clipper.

Because *music* is more degraded by intermodulation distortion than by harmonic distortion, one would expect results on music to be poorer with the Hilbert-Transform clipper than with a conventional audio-frequency clipper (This is true when comparing a conventional RF clipper with an AF clipper.) However, because of the distortion-cancellation circuit, results are instead approximately equivalent.

The HILBERT CLIPPER DRIVE controls determine the amount of peak limiting accomplished by Hilbert-Transform clipping. The loudness/distortion trade-off is primarily determined by these controls, and by the earlier DENSITY controls. Higher settings of the HILBERT CLIPPER DRIVE controls will result in a louder on-air sound. To obtain maximum coverage and speech intelligibility, set the CLIPPING control just below the point where clipping distortion begins to be disturbing. Note that this point will vary according to the amount of noise and interference at the radio, with increased noise demanding increased clipping to secure the most intelligible sound. (There are two HILBERT CLIPPER DRIVE controls, switched by the momentary PROCESSOR PRESET switch on the front panel, or by remote control.)

Gain reduction metering.

Unlike the metering on some processors, the **red zone** on the OPTIMOD-HF gain reduction meter's scale is a warning that must be observed. When the meter is in the red, it means that the compressor has run out of gain reduction range, that the circuitry is being overloaded, and that various nastinesses are likely to commence.

The meters should never enter the red zones if OPTIMOD-HF has been set up for a sane amount of gain reduction under ordinary program conditions. But be aware of the different peak factors on voice and music — if voice and music are peaked identically on a VU meter, voice may cause up to 10dB more peak gain reduction than does music! (A PPM will indicate relative peak levels much more accurately.)

Because OPTIMOD-HF has been designed to work best with a nominal broad-band AGC gain reduction of 10dB, the BROAD-BAND AGC G/R meter is calibrated so that "0" on the meter corresponds to 10dB gain reduction. (0dB on a MULTI-BAND LIMITER G/R meter indicates that no gain reduction is being applied to that band.)

The available range of the DENSITY controls is such that the middle three MULTI-BAND LIMITER G/R meters will probably never exceed 15dB of indicated gain reduction. However, because the gain reduction in the multi-band limiter consists of both a fast and slow component, the fast component may extend 6dB further than the reading on the meter (which is too slow to indicate it). Even so, there is no danger that the available G/R range of the multi-band limiter will be exceeded.

Gating.

The GATE THRESH control determines the lowest input level that will be recognized as program by the broad-band AGC; lower levels are considered to be noise and cause the AGC to gate, effectively freezing its gain.

Even when the AGC is in a gated condition, the broad-band gain reduction will eventually recover to 10dB (= 0 on the BROAD-BAND AGC G/R meter), but recovery is slow enough to be imperceptible. This avoids OPTIMOD-HF's getting stuck with a large amount of gain reduction on a long, low-level musical passage immediately following a loud passage.

It is not unusual to set the GATE THRESH control to "0". Higher settings are primarily useful for radio drama, outside sports broadcasts, and other non-musical programming in which it is undesirable to pump up ambiance, low-level crowd noise, and the like. Slightly higher settings may increase the musicality of the compression by slowing down recovery on moderate- to low-level musical passages. When such passages cause the gate to cycle on and off, recovery time will be slowed down by the ratio of the "on time" to the "off time". This effectively slows down the release time as the input gets softer and softer, preserving musical values in material with wide dynamic range.

If you hear soft passages in music fading away, then the GATE THRESH control is probably set too high (or the operator is peaking too low). If background noise rises slowly during pauses, then the control is set too low.

Other ways to increase loudness and coverage.

In recognition of the severe noise and interference problems often encountered in HF propagation, OPTIMOD-HF has been “tuned” to emphasize loudness and intelligibility. By comparison to our medium-wave processor, OPTIMOD-AM, OPTIMOD-HF has a more “forward” midrange balance and less bass. This is because bass costs modulation without contributing proportional intelligibility (it also can make intermodulation distortion worse during selective fading), and because a boosted midrange can most effectively cut through noise to provide intelligibility.

We are aware of no further external processing techniques that could be used to increase the coverage of a signal processed by OPTIMOD-HF. Any further improvements must come at the program source: immaculately clean audio be processed for loudness and coverage far more aggressively than can audio of less quality. Any distortion in the input audio will likely be exaggerated by OPTIMOD-HF, thus limiting the amount of coverage that can be achieved before objectionable distortion is produced. Read the Orban publication, *Audio Quality in the AM Plant*, for a wealth of information on improving the quality of your audio chain and production studio.

One other comment about equipment quality: many modulation monitors and RF amplifiers indicate higher modulation than the transmitter is actually producing. This may falsely induce you to decrease modulation. It is *very important* to be sure that your modulation monitor is accurately calibrated, and that it does not exhibit overshoot on program material.

Several newer monitors are specifically designed for accurate pulse response without overshoot. Any of these monitors will enable you to obtain the highest loudness and coverage achievable from your transmitter and antenna system. If the monitor is used remotely, be sure that the RF amp doesn't overshoot: overshoots in RF amps have been observed to be as high as 3dB also!

In general, it is far more reliable to set modulation by using an oscilloscope at the transmitter site to check for carrier pinch-off. The oscilloscope should be connected close to the final RF amplifier, as reactances in the antenna tuning circuits can cause phase shifts that will obscure the reading.

Judging loudness and intelligibility.

In trading-off the settings of OPTIMOD-HF's HF EQ BOOST, DENSITY, and HILBERT CLIPPER DRIVE controls to achieve the most favorable perceived compromise between brightness, loudness, and distortion, it is important to be aware of several factors. Best intelligibility requires that the “unvoiced” sounds in speech (like sibilance and fricatives) be clearly audible. Most of the energy contained in these sounds is above 2kHz, where most radios are already starting to roll off. Further, the energy in these sounds is small by comparison to the “voiced” sounds, so they will not contribute to a “loudness” measurement in proportion to their importance to intelligibility. Although loudness usually correlates reasonably well to intelligibility (because loudness is maximized by emphasizing energy in the 1 to 3kHz range where the ear's sensitivity is greatest), it is also important to maximize the apparent high-frequency response at the receiver (by aggressive pre-emphasis), even if this might reduce raw loudness slightly.

Apparent loudness will further vary with the frequency response of a given radio, and with the accuracy with which the radio is tuned. Narrow-band radios will usually get very much louder if tuned off center while a highly pre-emphasized signal is

being received. This means that a radio must be carefully tuned before meaningful loudness and intelligibility comparisons can be made between various settings of OPTIMOD-HF's set-up controls. A wide-band radio reproduces more of the frequency range in which the highly-equalized signal concentrates its energy (and to which the ear is most sensitive), so a highly equalized signal may sound less loud than an unequalized signal on a narrow-band radio, while the reverse is true on a wide-band radio.

Loudness is a very complex psychoacoustic phenomenon. One control setting cannot be judged to be louder or more intelligible than another unless it is *consistently* louder on many different receivers with many different types of program material, and with different levels of propagation impairments.

High-frequency equalization.

OPTIMOD-HF's high-frequency equalization curve is defined by the color-coded pre-emphasis module on Card #4. The 9105A is shipped with the **GREEN** pre-emphasis module installed. This module provides a steep-slope 18dB/octave "quasi-Chebyshev" pre-emphasis, shown in Fig. 3-1. We strongly recommend using the **GREEN** module because we believe that it compensates for the extreme high frequency roll-off in typical HF receivers more effectively than do any of the other supplied modules.

With the **GREEN** module installed, an HF EQ control setting of 22dB will result in a perceived bandwidth of 6kHz on an "group-2" AM radio with no 5kHz notch filter (a 15dB setting yields a 5kHz perceived bandwidth, 10dB yields 4kHz, and 5dB yields 3kHz perceived — of course, a bandwidth cannot exceed the cutoff frequency of OPTIMOD-HF's built-in low-pass filter). Greater amounts of high-frequency boost will result in a brighter, higher fidelity sound — but it will also require that the listener tune the radio more carefully. Extreme amounts of high-frequency boost may result in a slight "lisp" quality on certain voices. This is because while OPTIMOD-HF can produce a very loud sound on voice, sibilance can only be boosted to 100% modulation. If the relative balance between sibilance and the rest of the voice, is radically altered by high-frequency limiting of the sibilance, the listener may interpret this as a lisp.

Because some broadcasters may have different requirements or preferences, three other modules are supplied with the 9105A:

The **BLUE** module provides a single time-constant pre-emphasis curve with a zero at 75 μ s and a pole at 18 μ s. This module provides the North American NRSC recommended pre-emphasis curve when the 9105A's HF EQ control is turned fully clockwise. The bottom curve in Fig. 4-1 shows this response. When the audio bandwidth is 5kHz (as it is in HF broadcasting), the **BLUE** module provides a very modest effect, and we do not believe that it would be preferred unless your transmitter or antenna array has difficulty handling a large amount of high-frequency audio energy.

The **RED** module provides an 18dB/octave pre-emphasis that produces substantially less energy in the 4 to 5kHz range than does the **GREEN** module. It sounds better than the **GREEN** module on "group-1" radios (with a relatively gentle roll-off to 5kHz), but on most radios provides duller, less intelligible sound.

The **YELLOW** module is a compromise between the **GREEN** and **RED** modules.

Curve families for all the pre-emphasis modules are shown in Fig. 3-1.

If you wish to change the pre-emphasis module:

- A ☐ Turn off AC power.
- B ☐ Remove Card #4 from its slot, following the instructions on page 4-5.
- C ☐ Unplug the installed module and plug the desired module into the vacated socket.



The pre-emphasis module is located on Card #4. The assembly drawing on page 6-59 shows the location of the module.

- D ☐ Return Card #4 to its slot.
- E ☐ Replace the subpanel.

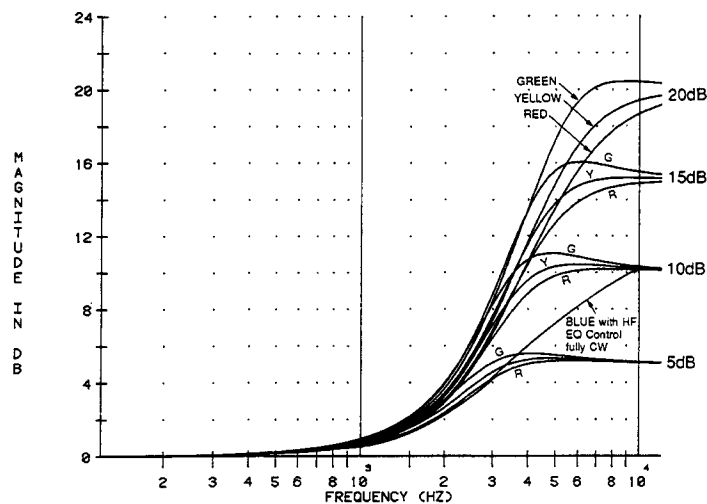


Fig. 3-1: Curve Families for Pre-emphasis Modules

Bass equalization.

Perhaps the most difficult of all processing tradeoffs in HF broadcast is choosing bass equalization. This is why OPTIMOD-HF is equipped with a bass equalizer capable of ± 6 dB of bell-shaped boost at 100Hz, and also with a defeatable 150Hz 6dB/octave high-pass filter.

When propagation conditions are good and the signal strength is high, a certain amount of bass boost (perhaps +3dB) provides the most pleasing sound. However, robust bass can easily induce intermodulation distortion, so the amount of Hilbert-Transform clipping must be reduced to provide acceptable distortion performance. In turn, this may compromise loudness by up to 3dB — the equivalent of cutting transmitter power in half!

Bass boost has a tendency to reduce the life of power tubes in most high-powered transmitters, and will also tend to induce intermodulation distortion in envelope detectors under selective fading, when detection becomes markedly non-linear because of sideband asymmetry. In short, the arguments for bass cut are usually more persuasive than those for bass boost. Yet if a broadcasting organization seeks the highest possible subjective quality regardless of transmitter operating cost, and feels that it usually delivers a strong RF signal, free from selective fading, to its listeners, then such an organization may still wish to slightly boost bass. OPTIMOD-HF's versatile set-up controls permit easy implementation of a given preference.

It is important to understand that the effect of the bass equalizer is relatively subtle, because bass balances are also affected by the action of the 150Hz and 420Hz bands of the multi-band limiter and multi-band distortion-canceling clipper. These bands will tend to make bass balances more uniform (partially "fighting" bass-balance changes made with the bass equalizer) by increasing bass in program material that is thin-sounding, and by limiting heavy bass to 5dB below 100% modulation to prevent disturbing intermodulation between bass and higher-frequency program material. By comparison to Orban's medium-wave processor OPTIMOD-AM, the threshold of limiting of the 150Hz band has been substantially lowered so that more gain reduction (and thus, less bass) is produced.

If you wish to modify OPTIMOD-HF so that its dynamic bass response is identical to that of OPTIMOD-AM, change R1 (on Card # 6) from $2.67K\Omega \pm 1\%$ to $8.06K\Omega \pm 1\%$ $\frac{1}{8}$ watt metal film, and similarly change R2 (on Card # 6) from $2.00K \pm 1\%$ to $1.00K \pm 1\%$. These resistors can be located on the Assembly Drawing for Card # 6 in Section 6 of this manual.

(The multi-band distortion-canceling clipper prevents hard-clipped bass square waves from appearing at the 9105A's output. Older transmitters may respond much better to this well-controlled, benign waveform than to the hard-clipped bass square waves produced by less sophisticated processing.)

Automatic equalization.

In addition to the equalization provided by the high-frequency and bass equalizers, OPTIMOD-HF modifies the spectral balance of program material with its multi-band limiter.

The multi-band limiter automatically corrects the frequency balance of substandard program material to help produce the much sought-after "uniform sound" without

the need for critical manual re-equalization of every piece of program material in the production studio.

Transmitter equalization.

The transmitter equalization controls (LF BREAKPOINT, LF EQ, DELAY EQ, and SHELF EQ) allow you to pre-distort OPTIMOD-HF's output to compensate for tilt, overshoot, and ringing in your transmitter and antenna systems. The proper method for setting these controls is given in the installation instructions in Section 2 (specifically in step 10 on page 2-12). It is important that the transmitter equalization controls are correctly set *before* subjective re-adjustment of the other controls.

Voice/music balance.

The habit some operators have of peaking the music low and hitting the pin of the VU meter on voice will result in an improper on-air balance between voice and music. OPTIMOD-HF maintains an impression of short-term dynamic range — this is one of the keys to its preservation of musical quality and to its lack of processing artifacts. When the DJ pegs the meter on voice, OPTIMOD-HF hears a very loud sound (voice) surrounded by much softer sounds (music) and tries to *maintain* this impression on the air. The cure is simple: peak voice and music closer together. In fact, best on-air balances can often be achieved by peaking voice 3–5dB *below* music when an VU meter is used. When a PPM is used, voice and music should be peaked reasonably close together.

Quality of source material.

As indicated above, a major potential cause of distortion is excess clipping in the Hilbert-Transform clipper. However, this distortion can sometimes yield *benefits* when reception conditions are poor. Another cause is poor-quality source material, including the effects of the station's playback machines, electronics, and studio-to-transmitter link. No benefits *ever* accrue from distortion produced here! If the source material is even slightly distorted, that distortion can be greatly exaggerated by the OPTIMOD-HF — particularly if a large amount of gain reduction is used. Super-clean audio can be processed harder without producing objectionable distortion. Orban's *Audio Quality in the AM Plant* explains how to improve source quality.

Notes: